

# UTILITY DESIGN GUIDELINES

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### **I. Purpose and General**

The intent of these design guidelines is to provide direction and guidance to design professionals regarding the University of New Mexico utilities systems and minimum expectations for the design of new and renovated service connections. No connection to the utility systems described herein can be made to any component of a proposed addition without the expressed written approval of the PPD Utilities Division. Designers and contractors should make every effort to assure that prior approval of proposed systems and components by the Utilities Division is obtained prior to construction of such elements.

Refer to addenda, standard details and specifications for additional information relating to individual utilities.

### **II. Domestic Water & Sewer**

#### Part 1 - General

The domestic water system at UNM consists of wells and pumps, interconnections to the Albuquerque Bernalillo County Water Utility (ABCWUA) system, a 1.2 million gallon storage reservoir, and 80 psig distribution piping. This guideline is intended to assist the designer in designing a new or renovated domestic water system that will be compatible with current or future connection to the UNM system.

The Main campus is served by an exterior direct buried loop system in the Redondo/Campus loop road. This system augments an older interior system which is distributed primarily in the UNM tunnel system. Best service is obtained by a direct connection to the exterior loop, but adequate service is generally available on the interior loop. The designer of a new or renovated building system should coordinate with the staff of the Physical Plant Utilities Division for the particulars of the specific domestic water

assets in the vicinity of the project under design. The particular project location will determine if the project will need to be connected to the interior, exterior or ABCWUA systems. The ABCWUA provides backup water supply to the campus system. The condition of the well or distribution system pumps is monitored at the Ford Utilities Center. The system can be switched manually or remotely to the ABCWUA system on a failure of the UNM facilities.

The system serves the North Campus with redundant piping in the utility tunnels. An exterior direct-buried loop has been started at the north end of the tunnel system. University of New Mexico Hospital (UNMH) is connected to both the UNM and ABCWUA systems, with UNM acting as backup.

The sanitary sewer system is provided through a private (university-owned) collection system connected to the City of Albuquerque Sanitary Sewer System.

## Part 2 – Design Guidelines

Individual metering and cross-connection protection is required for each individual building. Intra-building cross-connection protection should follow ASPE cross-connection prevention guidelines. Building meters may be inside the building but must be accessible to maintenance personnel. Main backflow preventers shall be located inside the building. A reduced-pressure backflow device must be provided at every connection to the water system. Double check valves are not allowed.

Sanitary Sewer - Sanitary sewer service is provided through a private (university-owned) collection system connected to the City of Albuquerque Sanitary Sewer System. Design and installation should comply with the City of Albuquerque Standards. Buildings with separate lab waste systems should include a sampling manhole outside of the building prior to combination with the normal building waste stream.

## III. Steam and Condensate

### Part 1 – General

North/Central Campus Steam Distribution - Steam is generated and distributed at service pressures of 125 psig and 40 psig. Steam is available year round, but the pressures may vary up to 20% during peak loads. The low-pressure heating mains will normally maintain a minimum of 25 psig at the buildings; the pressure will vary depending upon demand. The most common building pressures are 40 psig and 15 psig.

### Part 2 – Design Guidelines

The standard design manual for steam, water, and gas piping is the American Society of Plumbing Engineers Data Book and associated supplements. Planning and Campus Development has detailed location information on many underground utility sites. On-campus design professionals and Physical Plant personnel can provide further information on specific sites.

Documentation of designs should include detailed information on as-built existing conditions of distribution systems being connected to, and should provide the same level of detail on new installations. Profile drawings of new underground utilities are required, as are locations of existing utilities which may be disturbed or encountered during excavation. Designers are required to update drawings to reflect as-built conditions upon completion of construction.

All steam, condensate, and domestic water lines within the building envelope shall be insulated. Uninsulated mains or run-outs shall not be used as heat

sources. Chases and stack areas carrying heating lines in the building should be adequately ventilated to prevent overheating due to piping losses.

All connections to mains shall be valved, both sides of the connection to the main and at the building.

All new piping shall conform to the color scheme cited in section 15075 or be stenciled with type of service and direction of flow.

The heating system should not be depended upon to provide process steam.

Piping and Connections - All new buildings must be provided with steam meters. Steam should be metered directly, unless specific prior approval from the PPD-UD is obtained for condensate metering. Condensate meters should be placed on the discharge side of the condensate pump. A three-valve bypass around meters should be provided. Where ever possible, steam and condensate piping shall be installed in such a manner as to allow for gravity return of condensate. The designer is to provide drip lines and air vents as needed to assure ease of operation. The project manager shall coordinate all connection of new services to the steam mains with PPD-UD personnel.

No connections to the steam mains shall be made without proper approval and inspection by PPD-UD. The building steam system shall not be energized without final inspection and approval of the PPD-UD, who shall operate all valves during start-up.

Steam reducing stations should configured in a 1/3 and 2/3 flow arrangement for both regulators and control valves

#### Campus Steam Distribution

- Exterior steam and condensate lines shall be installed, in order of preference, in fully accessible walkable concrete utility tunnels, semi-accessible pre-cast concrete tunnels, or shallow trenches.
- Pre-insulated direct buried piping systems will be reviewed on a case-by-case basis, typically for service from the main connection to the building. Carrier pipes will be separately cased. Multiple carrier pipes in a single casing shall not be used
- Expansion loops or accessible expansion joints shall be used for expansion compensation in shallow trenches. Expansion joints will be used in tunnels.
- Steam pipe shall be schedule 40 black steel pipe with 250 pound rated fittings in the distribution to the first pressure reducing station in the building. Steam piping shall be all welded construction.
- Condensate pipe shall be schedule 80 black steel pipe with schedule 80 fittings. Condensate piping shall be all welded construction to the first valve in the drip leg. Threaded fittings are permitted for use on the drip leg after the first valve.
- Ball Joints must be able to be re-packed. If installed in the vertical position,

choose ball joints that have the male end pointed down.

- Strainers on the 125 psig system shall be 150 psig rated cast steel, 300lb flange rating, with a stainless steel standard screen.
- Hand Valves:
  - Shutoff service: Rising stem, steel forged gate valves are preferred.
  - Flow control service: globe valves are preferred

#### Drip Legs and Steam Traps

- Inverted bucket or thermodynamic F&T traps shall be specified for use on drip legs.
- Each trap will be sized based on the amount of condensate calculated for the distribution.
- High-pressure condensate from the drip legs shall not be directly introduced to the pumped wet condensate return system.
- Stainless steel spring checks are to be used on the condensate return system.
- Threaded steel forged valves are to be used on steam trap assemblies.
- No copper piping or checks with Teflon seats are authorized on steam trap assemblies.

#### Insulation

- Insulation material on steam and condensate piping in tunnels shall be calcium silicate. Insulation thickness shall be as required by the latest ASHRAE Standard for buildings, but applied to utility construction.
- Insulation shall be provided on all piping, flanges, valves, etc. to reduce heat gain in the tunnels.
- Aluminum jacket shall be used in tunnels and plants on all piping, fittings, etc. Aluminum jacket shall be provided on valve bodies up to the flanges for the gland packing to allow for service of the gland.
- Use 30-pound asphalt-impregnated felt jacket or other suitable material to protect insulation of pipes in concealed spaces from abuse during construction and from future deterioration. In high traffic areas, where insulated pipes are subject to mechanical abuse, metal covering or structural protection shall be provided. Wire used for securing pipe coverings shall be solid copper, stainless steel, or other non-ferrous material with a long service life.

#### Materials

**Table 1: Low Pressure Piping Materials Schedule**

<b>Item</b>	<b>Size</b>	<b>Description</b>
Piping	All sizes	Seamless sch-80 – Carbon Steel Pipe
Piping	All sizes	150 psig – Design Pressure
Piping	All sizes	550 °F – Design Temperature
Piping	All sizes	225 psig – Hydrostatic Test Pressure
Fittings	2" and under	Malleable steel - screwed or welded
Fittings	2 1/2" and over	Malleable steel – welded
Flanges	All sizes	300 lb. raised face
Bolting	All sizes	Alloy steel ASTM A193 grade B7 bolts and studs with A194 grade 2H nuts
Unions	2" and under	300 lb., raised face, SW, integral SS seat
Gaskets	All sizes	300 lb., 3/16" thick, spiral wound with 1/8" thick outer guide ring, 304 SS with Verdicarb Filler
Take-off	2" & under main 2" & under branch	Socket weld tees
Take-off	2½" & over main 2" & under branch	Reducing tee forged steel sock-o-let
Take-off	2½" & over main 2½" & over branch	Equal or reducing tee, nozzle weld with reinforcing as required, forged steel weld-o-lets

**Table 2: High Pressure Piping Materials Schedule**

<b>Item</b>	<b>Size</b>	<b>Description</b>
Piping	All sizes	Seamless sch-80 – Carbon Steel Pipe
Piping	All sizes	150 psig – Design Pressure
Piping	All sizes	550 °F – Design Temperature
Piping	All sizes	300 psig – Hydrostatic Test Pressure
Fittings	2" and under	Malleable steel - screwed or welded
Fittings	2 1/2" and over	Malleable steel – welded
Flanges	All sizes	300 lb. raised face
Bolting	All sizes	Alloy steel ASTM A193 grade B7 bolts and studs with A194 grade 2H nuts
Unions	2" and under	300 lb., raised face, SW, integral SS seat
Gaskets	All sizes	300 lb., 3/16" thick, spiral wound with 1/8" thick outer guide ring, 304 SS with Verdicarb Filler
Take-off	2" & under main 2" & under branch	Socket weld tees
Take-off	2½" & over main 2" & under branch	Reducing tee forged steel sock-o-let
Take-off	2½" & over main 2½" & over branch	Equal or reducing tee, nozzle weld with reinforcing as required, forged steel weld-o-lets

**Table 3: Condensate Piping Materials Schedule**

Item	Size	Description
CR Pipe	All sizes	Seamless sch-80 – Carbon steel
CP Pipe	All sizes	Seamless sch-40 – Carbon steel
Piping	All sizes	Design Pressure - 100 psig Design Temperature - 220 °F Hydrostatic Test Pressure - 150 psig
Fittings	All sizes	Malleable steel – screwed or welded
Unions	2" and under	300 lb., raised face, screwed, integral SS seat

## IV. Chilled Water

### PART 1 - General

- 1.1 The central chilled water systems at UNM consist of direct pumped primary chilled water distribution piping from central plants and limited stand alone building chillers. This guideline is intended to assist the designer in designing a new or renovated building system that will be compatible with current or future connection to the UNM district cooling system.
- 1.2 The designer of a new or renovated building system should coordinate with the staff of the Physical Plant Utilities Division for the particulars of the specific chilled water assets in the vicinity of the project under design. The particular project location will determine if the project will provide a building chiller or connect to existing chilled water distribution piping.
  1. **Specific Design Information:** The actual pressures within the campus-wide system at a specific building/site at any given time depends upon that building's location along the distribution system, the weather conditions, the time of year as well as the time of day. Information related to the projected availability of chiller plant capacity, distribution system capacity and system pressures can be obtained on request to the PPD-UD which uses a software system simulation utilizing real-time and historical system data.
- 1.3 Central chilled water will be operated year round with a supply temperature of 42 °F in the summer, 50 °F in the winter.
- 1.4 Each building will use a direct connection to the district cooling system without the use of building pumps. The building coils shall be controlled at the coil air discharge such that the temperature rise shall not be less than 16 °F with the supply temperatures given in 1.3.
- 1.5 Pumps and plate heat exchangers will only be allowed for buildings with height restrictions that would prevent filling the system completely from the district cooling system.

### PART 2 - Design Guidelines

#### 2.1 General

- The designer's goal should be to design a building system that can function as closely as possible as a variable flow, constant temperature rise system over the entire load range for all seasons.

- Design pressure for all components should be at least 250 psig at 100°F.
- Design fill pressure shall be 40 psig.
- Pipe all system drains to sanitary sewer. Provide brass hose adapter, cap and chain on all vents and drains.

## 2.2 Coils

- All chilled water coils shall be selected on the basis of 42° F summer, 50° F winter entering water temperatures and 58° F leaving water temperature. Minimum tube velocity shall be 4 fps at full load condition. Select coils to maintain a 16 °F  $\Delta T$  from 100% load down to 25 % part load.
- Specify two way control valves for all coils and provide variable flow loop for the building or process loop. All control valves and operators shall be selected for the full possible pump head on the loop. Control valves shall be in accordance with the HVAC controls design guideline.
- All coils shall have non-ferrous headers and tubing.

## 2.3 Direct Buried Piping System

- General: All underground piping for chilled water system distribution shall have a minimum diameter of 4" and shall be cement lined ductile iron.
- Pipe Restraint: All distribution piping should be fully mechanically restrained, requiring no thrust blocking.
- Ductile Iron Pipe: Pipe shall conform to AWWA C151 minimum class 50. All ductile iron pipe shall be cement mortar lined in accordance with AWWA C104 and shall have asphaltic coating. Piping 4" – 12" shall have 350 psig minimum working pressure. Piping 14" – 24" shall have a 300 psig minimum working pressure.
- Select backfill material shall be provided for bedding and backfill 12" above pipe.
- System drains and vents – Provide system drains at low points and system vents at high points.
- Fittings: Fittings for ductile iron pipe shall be ductile iron and rated a minimum of 250 psi working pressure. Fittings shall be cement mortar lined equivalent to the pipe lining.
- Mechanical Joint Fittings: Comply with AWWA C110. Where restrained joints are identified, use Megalug Series 1100 system or approved equal. Gasket material shall be SBR
- Push-on Joint: Comply with AWWA C111
- Butterfly Valves: Comply with AWWA C504. Valve shaft to be type 304

stainless steel. Cast valves from gray or ductile iron. Provide interior coating of body and disk. Valves shall be furnished with buried service gearbox operator, shaft extensions, ground level position indicators and valve boxes.

- Gate Valves: Comply with AWWA C509. Stem shall be non-rising and shall be cast bronze. Valve body and wedge shall be ductile iron and shall be coated inside and outside with epoxy. The coating shall meet or exceed AWWA C550. Valves shall have a minimum pressure rating of 250 psi. Gate valves shall be US pipe or approved equal.
- Valve Boxes: Valve boxes shall be 2 piece cast iron with heavy duty traffic weight lid marked with valve number as shown on drawings (such as CWS – 22). Valve boxes not in paving shall be supplied with a pre-cast concrete mowing ring.

#### 2.4 System Pressure and Leak Test

- Length of test, unless otherwise approved, shall be a minimum of 4 hours. Contractor shall have conducted a preliminary pressure test prior to final acceptance test to locate and correct any pipe leaks.
- Chilled water piping shall be leakage rate tested. Leakage rate test shall be conducted at the same time as the hydrostatic pressure test. Leakage rate is defined as the quantity of water that must be supplied into respective underground piping system to maintain pressure within 5 psig of the specified hydrostatic test pressure after system has been vented and filled. Contractor shall document test results and sign/date each test.
- The maximum allowable leakage is determined by the following formula:

$$L = N \cdot D \cdot (P)^{1/2} / 7,400$$

where:



L = allowable leakage (GPH)

N = number of joints in length of pipe line tested D = nominal pipe diameter (inches)

P = average test pressure during leakage test (psig)

- If measured leakage rate exceeds maximum leakage rate, repair with new materials and repeat test until satisfactory results have been obtained.

## 2.5 Control Logic

- The discharge air leaving each building coil shall be maintained at the design temperature
- Additional logic assuring leaving chilled water temperature of no less than 58 °F without compromising building cooling capacity is encouraged.

## 2.6 Building Service Entry

- Each building shall include as a minimum, shutoff valves, temperature and pressure gauges, system drains and metering in accordance with metering guideline.

## 2.7 Accessible Distribution System Piping

- Piping in accessible tunnels and mechanical spaces shall be schedule 40, black steel pipe.

# V. Electric Generation and Distribution

## Part 1 – General

The electrical systems at UNM consist of electrical production facilities, paralleling interconnections to Public Service Company of New Mexico (PNM), and distribution on 12.47 KV primary selective dual radial distribution system. This guideline is intended to assist the designer in designing a new or renovated electrical system that will be compatible with current or future connection to the UNM distribution system.

UNM owns the substations that serve the Main and North campuses. The substations receive power from PNM at 115 KV and transform it to 12.47 KV for campus distribution. The substations are interconnected on the secondary side to provide redundant transformer capabilities.

## Part 2 – Design Guidelines

The designer of a new or renovated building system should coordinate with the staff of the Physical Plant Utilities Division for the particulars of the specific electrical assets in the vicinity of the project under design. The particular project location will determine if the project will need to be connected to the local utility or to the UNM electrical system. UNM prefers to own, rather than lease, the facility transformer when connected to PNM.

Electrical power is provided to the UNM Main and North campuses from the UNM-owned substations at 12,470 volts on a primary selective, dual radial distribution system.

The system consists of two 500 MCM, 15 KV circuits distributed in buried ductbank to facilities on two switched "A" and "B" radials.

Facilities are served from the system utilizing one to four SF6 vacuum breakers which feed the facility transformer(s).

Portions of an older 115 KV / 4160 V distribution still exist on the Main Campus. The designer should coordinate with the staff of the Physical Plant Utilities Division for the particulars of the existing system. In general, no new connections to the 4160 V system will be allowed.

The university is the principal provider of electric power throughout the campuses. Some facilities, located on the perimeter of existing infrastructure systems, may be served directly by Public Service Company of New Mexico (PNM). The designer must include provisions for underground duct bank, manholes, pad-mounted transformers, switching devices, cables and standby generation to be included in the construction. The university will operate and maintain the switches and transformers but this equipment must be provided by the project. In addition, the switches and transformers must comply with the university specifications. See Appendix A - Division 16 - Electrical specifications for additional information.

The Main and North campus electrical system is monitored at the Ford Utilities Center through a Rockwell Power Management System. The system monitors power flows throughout the system and is capable of shedding load on an upset event. All new electrical facilities shall have relays and equipment compatible with the system to allow the equipment to be remotely operated.

## **VI. Natural Gas**

### **Part 1 – General**

Limited natural gas service is available at 5 psig throughout most of the North and Main campuses from a UNM-owned distribution system in the tunnels.

Natural gas is also available on the North and South campuses directly from local utility company lines. Metering and lateral piping into each new building should be included in the contract.

### **Part 2 – Design Guidelines**

Gas Distribution Piping - Any gas distribution network must include a pressure-reducing station that is valved on both sides. All gas meters should be located on the outside of the building. A 3-valve bypass piping arrangement should be supplied around the meter

## **VII. Telecommunications and Data**

The university is the primary provider of voice and data services throughout the Campuses. The designer must include provisions for raceways, wiring, and patch panels to be included in the construction. Separate guidelines are available from the UNM ITS Department. In general, no communications or data services are to be run

in the tunnels.

## **VIII. Identification of Underground Utilities and Piping**

### Part 1 - General

All underground piping and utilities (both metallic and non-metallic), except lawn irrigation lines, shall have two stages of identification and/or warning by a combination of non- detectable and detectable warning tapes.

### Part 2 – Design Guidelines

#### Identification Tape (non-detectable warning tape)

The 1st stage of identification shall be a buried non-detectable warning tape. This tape shall provide an early warning at shallow depth excavation. The tape shall be 6" wide, and buried approximately 18" to 30" above the service pipe, but a minimum of 10" below finished grade. It shall consist of multiple layers of polyethylene with an overall thickness of 3 to 5 mils. It shall be installed continuous from valve box to valve box or manhole to manhole, and shall terminate just outside of valve box or manhole wall. The black colored lettering on the warning tape shall be abrasion resistant and be imprinted on a color-coded background that conforms to APWA color code standards.

#### Warning Tape (detectable warning tape)

The 2nd stage of identification shall be a detectable warning tape. This tape shall provide pipeline identification, be fully detectable from above grade utility locators, and be able to provide a depth reference point to top of pipe. It shall be 6" wide, installed directly on top of the pipeline and permanently secured to the pipeline at 10' intervals. The tape shall consist of aluminum foil core or stainless steel tracer wires laminated between multiple layers of polyethylene tape with an overall thickness of 4 to 6 mils. Detectable core or tracer wire "circuit" shall be continuous from valve box to valve box or manhole to manhole for complete pipeline detection and location. Tape manufacturers' approved splice kits shall be used for long runs. Warning tape shall terminate just inside of valve box cover or manhole ring cover and be easily accessible for "clip-on" type utility location meters. The black colored lettering on the warning tape shall be abrasion resistant and be imprinted on a color- coded background that conforms to APWA color code standards.

#### Tracer Wire

All non-metallic pipe, including lawn irrigation lines, and metallic pipe with compression gasket fittings installed underground shall have a tracer wire installed along the length of the pipe. The wire shall be taped to the bottom of the pipe at a maximum of 10' intervals and not allowed to "float freely" within the backfill. Tracer wire shall be single-conductor, 10 gauge minimum, copper single-conductor wire with type "UF" (Underground Feeder) insulation, and shall be continuous along the pipeline passing through the inside of each valve box.

## **IX. Metering**

### Overview

The University of New Mexico Physical Plant Utilities Division (PPD-UD) manages and operates a District Energy System (DES) on the Main and North Campuses that provides the utilities listed in 2.1B below. PPD-UD requires that any facility that connects to at

least one of these DES utilities be provided with whole facility instrumentation and metering devices meeting this guideline sufficient to determine the consumption of the various utilities connected to the facility. Facilities that do not connect to the DES utilities may be required to meet this guideline based on the project scope and program.

The Energy Metering System (EMS) is a networked metering, monitoring, and verification system comprised of facility hardware, facility software, network equipment, EMS servers, and EMS software. This guideline includes the facility hardware and software, but the project budget must fund all components of installation including hardware, software, commissioning, and installation provided by PPD-UD. PPD-UD will provide the project manager with estimates of the cost of those items provided and installed by PPD-UD.

The facility is instrumented locally for each of the DES utilities to which it is connected. The instruments are wired to a Building Utilities Metering Panel (BUMP) provided by PPD-UD. This panel contains a programmable logic controller and other hardware necessary to provide and display continuous historical and instantaneous metering of the facility. The BUMP reports data over the campus WAN on a secured network to the remote EMS servers where it is stored for management information and reporting purposes. The contractor(s) who provide the utility metering for the facility are required to coordinate with the PPD-UD personnel and contractors to assure a complete working system.

The system also provides a backbone for reporting and operation of the facility Direct Digital Control System (DDCS) which is described in other guideline(s).

## PART 3 - GENERAL

### 3.1 SECTION INCLUDES

- A. This document covers the metering guidelines for typical UNM facility utility metering.
- B. The facility utilities to be metered are:
  - 1. Chilled Water
  - 2. Steam
  - 3. Condensate
  - 4. Natural Gas
  - 5. Domestic Water
  - 6. Electric

## PART 2 EQUIPMENT

### 2.1 GENERAL REQUIREMENTS

- A. The exact location and arrangement of pipe upstream and downstream of the flow sensors shall be based on the manufacturer's recommendations, requirements, and specifications.

- B. Typical operating range design information is as follows:
1. Chilled Water
    - a. Temperature Range: 35-100 degree F
    - b. Pressure Range: 20-80 psig
  2. Steam
    - a. Temperature Range: 100-350 degree F
    - b. Pressure Range: 0-150 psig
  3. Condensate
    - a. Temperature Range: 100-350 degree F
    - b. Pressure Range: 0-50 psig
  4. Natural Gas
    - a. Pressure Range: 0-20 psig
  5. Domestic Water
    - a. Pressure Range: 0-100 psig
  6. Electric: as required by the building design, but generally transformed from primary 12.47 KV or 4160 V to 208/3p/4W or 480/3p/4W.
- C. All transmitters shall have the following characteristics with no exception (unless otherwise indicated within this guideline)
1. Input power 24VDC
  2. Output Signal: 4-20mA
- D. Each instrument shall be labeled with a brass tag secured to the instrument indicating calibration range, building number, and service
- E. Calibration label on instrument shall indicate last factory calibration date.
- F. All instrumentation shall be calibrated using local barometric pressure.
- G. Each instrument shall have a local readout installed in an easily accessible location irrespective of the actual instrument location.
1. Each instrument shall transmit both instantaneous (4-20ma) and totalization signals (pulse). Instantaneous and totalization values will be displayed on the local readout.
- H. All in-line meters will be installed with a full size bypass with isolation valves on either side of the meter and one on the bypass.
- I. All instrumentation shall be rated to operate in an ambient temperature of 32 - 185 degrees F and calibrated for an altitude of 5200'.
- J. All transmitter enclosures shall be rated at a minimum of NEMA 4 with a minimum of two 3/4" electrical hubs with plugs.
- K. All instrumentation shall be Hart-compatible.

## 2.2 CHILLED WATER METER FLOW METER AND TRANSMITTER

- A. Flow sensor and transmitter shall be Foxboro or prior approved equivalent meeting the following:
- B. Flow sensor shall be corrected mass-flow, flanged in-line “magpipe” electro- magnetic technology.
- C. Maximum pressure drop across meter assembly at maximum design flow: 1.0 psi.
- D. Accuracy:  $\pm 1.0\%$  of flow across full range for given pipe size.
- E. Minimum turndown ratio: 100:1.

### 2.3 STEAM METER FLOW SENSOR AND TRANSMITTER

- A. Flow sensor and transmitter shall be Foxboro or prior approved equivalent meeting the following:
- B. Flow sensor shall be capable of mass flow (corrected for temperature and pressure), flanged in-line vortex-shedding technology, but shall be calibrated for volumetric flow (mass flow conversion and correction occurs in the BUMP).
- C. Maximum pressure drop across reduced-size meter assembly at maximum design flow: 5.0 psi.
- D. Accuracy:  $\pm 1.0\%$  of flow across full range for given pipe size.
- E. Minimum turndown ratio: 100:1.
- F. Flow Sensor Material: 316 Stainless Steel.
- G. Flanges and piping shall be of Class (generally 150 or 300) and Schedule (generally 40 or 80) matching that of the piping in which it is installed.

### 2.4 DOMESTIC WATER METER AND TRANSMITTER

- H. Flow sensor and transmitter shall be Turbo Badger Meter or prior approved equivalent meeting the following
- I. Flow sensor shall be in-line turbine type flow meter.
- J. Maximum pressure drop across reduced-size meter assembly at maximum design flow: 1.8 psi.
- K. Accuracy:  $\pm 1.5\%$  of flow across full range for given pipe size.
- L. The housing will be cast bronze with all internal pieces made of durable

material such as thermoplastic or stainless steel. All bearings shall be self-lubricating.

- M. The domestic water meter will be provided with a strainer on the utility side of the meter. The strainer will be installed so as to allow ease of maintenance.

## 2.5 NATURAL GAS METER

- A. Flow sensor and transmitter shall be American Meter Company or prior approved equivalent meeting the following
- B. Flow sensor shall be in-line diaphragm type flow meter.
- C. Maximum pressure drop across reduced-size meter assembly at maximum design flow of 2" W.G..
- D. Accuracy:  $\pm 1.0\%$  of flow across full range for given pipe size.
- E. The housing will be die-cast aluminum case. All bearings shall be oil-impregnated self-lubricating bearings. All seals shall be long-life grommet seals. The housing and all parts will be rated for outdoor.

## 2.6 ELECTRIC METER

- A. Meter shall be a Shark 200 with Ethernet card or prior approved equivalent meeting the following
- B. Electrical meter shall be installed in the main electrical distribution panelboard with local scrollable display.
  - 1. Where required by the project, additional submetering may be necessary on building branch circuits. All such meters shall meet this guideline.
- C. The meter shall be capable of measuring current and voltage on all phases including neutral. Meter shall be rated for 60 Hz power.
- D. All shorting blocks will be provided with the meter. Shorting blocks shall be capable of being remotely located within the electrical equipment.
- E. The meter will be provided with matching CT's and any required PT's for a complete installation. All CT's will be removable for ease of maintenance.
- F. Accuracy:  $\pm .075\%$  of full-scale reading.
- G. Meter sampling will be zero blind rate 128 samples/cycle.
- H. Meter shall be able to provide up to 63<sup>rd</sup> harmonic content of current.

- I. Meter shall be able to provide waveform capture of a minimum of 3 cycles at 128 samples/cycle.
- J. The meter will have the following data capable of being transmitted to an Ethernet switch via the Ethernet card:
  - 1. All Phase Currents (A, B, C, N in Amps)
  - 2. All Phase-Phase and Phase-Neutral Voltages (in Volts)
  - 3. KW Demand (KW)
  - 4. Accumulated Power (Megawatt-hours)
  - 5. Harmonic Content, (A, B, C, N in Percent)
- K. Meter will have the following alarm capable of being transmitted to the Ethernet switch
  - 1. All Phase Faults (A, B and C)
  - 2. All Phase Voltage spikes
  - 3. Meter General Alarm
- L. Meter shall comply with UL 508.
- M. Output communication of the meter shall be Modbus over IP via the Ethernet card.
- N. The electric meter does not directly connect to the BUMP. Rather it connects to the Ethernet switch via Cat 5/6 cable (to match the building standard).
  - 1. The Ethernet switch is that for the PPD Utilities VPN, usually located in a UNM-IT wiring closet (TR). Depending on equipment locations the Ethernet switch within the BUMP may be used instead.
- O. Solar PV system metering
  - 1. Solar PV systems will have a submeter matching the electric meter specifications.
  - 2. In addition, solar PV systems will be equipped with an Egauge 3 series meter with an independent Ethernet connection to the nearest TR.

## 2.7 TEMPERATURE SENSOR, TRANSMITTER AND WELL

- A. Sensor, well and transmitter shall be Rosemount, Foxboro, or prior approved equivalent.
- B. Temperature sensor shall be well type 3-wire, platinum, 1000 ohm RTD.
- C. The sensor shall include well. Temperature wells shall be constructed of Type 304 stainless steel to the proper depth, with 3/4" NPT pipe



connections, and extension neck for insulated lines. Wells shall be furnished with screw plug attached to wells with chain to keep dirt out when not in use. 3/4" thread-o-lets shall be welded to the pipe to receive wells.

- D. Accuracy:  $\pm 0.075\%$  of calibrated span.
- E. Minimum Update Rate: 20 times per second.
- F. Individual well type temperature sensors and transmitters will be provided for:
  - 1. Chilled Water Return
  - 2. Chilled Water Supply
  - 3. Steam
  - 4. Condensate

## 2.8 PRESSURE SENSOR AND TRANSMITTER

- A. Sensor and transmitter shall be Foxboro.
- B. Minimum Update Rate: 20 times per second.
- C. Meet NFPA 70 501-5.
- D. Pressure assembly shall include appropriate tap, stop valve, snubber, and block and bleed valve along with sensor.
- G. Individual pressure sensors and transmitters will be provided for:
  - 1. Chilled Water Return
  - 2. Chilled Water Supply
  - 3. Steam

## 2.9 BUILDING UTILITY METERING PANEL CONNECTION REQUIREMENTS

- A. Provide a separate 120VAC, 20 A, GFCI, isolated, surge-suppressed emergency-powered circuit for BUMP and auxiliary panel power.
- B. Provide a UNM network connection from the ITS closet to the BUMP.

## 2.10 NETWORK EQUIPMENT AND RACKS

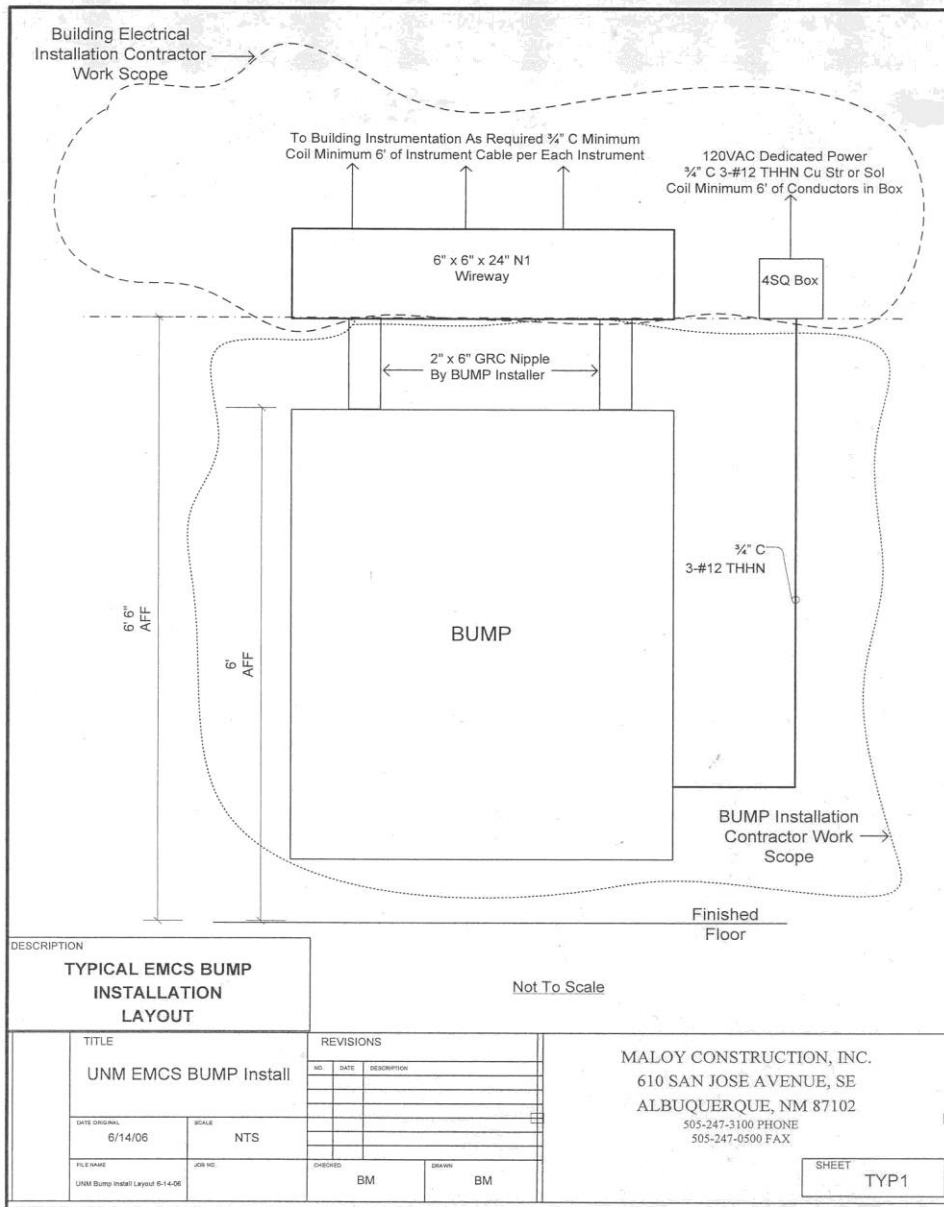
- A. Provide sufficient space and power in the ITS network closet racks for the VPN firewall and FieldServer devices.
- B. Provide location and power for auxiliary panel in ITS closet.

## PART 3 – EXECUTION

### 3.1 BUMP INSTALLATION:

- A. All terminations shall be wired and installed in separated gutter located above the designated BUMP location meeting the facility construction specifications for combined power and instrumentation wiring. The building contractor shall leave six (6) feet of coiled wire for each termination.
- B. All wiring shall be color-coded and tagged with sufficient information to determine the instrument to which it is connected.
- C. When so notified by the project manager that the installation is complete, and it is safe for the BUMP to be installed, PPD-UD shall provide and install the BUMP.
- D. The contractor shall coordinate, cooperate, and provide all necessary assistance during the commissioning and startup of the facility metering system by PPD-UD.
- E. Although not necessarily part of the contractor's scope, the project must also coordinate, cooperate, and provide all necessary assistance during the integration, commissioning and startup of the facility metering system connection to the campus EMS.

## F. BUMP installation diagram



### 3.2.1 APPROVALS

- A. PPD Utilities Division must approve all drawings and specifications at each design stage in writing before proceeding to the next stage of design. Approval of the building design stage does not imply approval of the metering system design.

Prior approvals for equipment not specifically mentioned in this guideline must be approved by the PPD Utilities Division at least fourteen (14) days prior to bid. In order for the approval request to be reviewed, the supplier of the proposed equipment must include model number, full specifications, performance, cut sheets, and all necessary information that unambiguously shows that the proposed equipment meets the full requirements of this guideline. The supplier must also show conclusively that the equipment will communicate properly with the BUMP, either by demonstration or proof that such equipment has performed as required by this guideline in equivalent installations. The determination of equivalence and approval is by the PPD-UD whose decision shall be final. If the equipment is approved, it will be added by name, manufacturer, and model number as acceptable for future projects.

## **X. Connection to Utilities**

Prior to connection to UNM Utilities, the Connection Checklist and Approval must be completed. Those checklists are available on the PPD web page at [PPD.UNM.EDU](http://PPD.UNM.EDU) under Standards & Checklists.



## **ADDENDUM A: CONSTRUCTION SPECIFICATIONS**

### **THESE SPECIFICATIONS UNDER REVISION**

The attached specifications should be used as a guideline for the building or plant specifications. The final design and specifications must be approved by PPD-UD before interconnect of the building with the required site utilities is allowed. The following specifications are attached:

#### **DIVISION 2 – SITEWORK**

- 02060 General Site Requirements
- 02221 Excavation, Trenching and Backfilling for Utilities Systems
- 02270 Temporary Erosion Control
- 02718 Direct Buried Chilled Water System and Cooling Tower Connection Piping
- 02719 Water System
- 02720 Underground Chilled Water Piping Insulation
- 02827 Swing Gates
- 02990 Pre-cast Steam Tunnel

#### **DIVISION 15 – MECHANICAL**

- 15010 Mechanical General Provisions
- 15050 Basic Mechanical Materials and Methods
- 15060 Utility Plant Piping and Valves
- 15120 Utility Plant Piping Specialties
- 15160 Pumps and Pump Motors
- 15250 Mechanical Systems Insulation
- 15520 Steam and Steam Condensate Piping and Valves
- 15525 Steam and Steam Condensate Specialties
- 15545 Chemical Water Treatment
- 15684 Centrifugal Water Chillers
- 15712 Cooling Towers
- 15910 Identification
- 15975 Central Plant Automation System
- 15990 Testing, Adjusting and Balancing
- 15995 Mechanical Systems Commissioning
- 15997 Mechanical Testing Requirements

#### **DIVISION 16 – ELECTRICAL**

- 16010 Basic Electrical Methods and Requirements
- 16015 Electrical Work
- 16050 Electrical Commissioning
- 16110 Ductbank
- 16120 Manholes
- 16121 Grounding and Installation Methods

SECTION02060

GENERAL SITE REQUIREMENTS

PART 1 GENERAL

1.1 RELATED DOCUMENTS:

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work of this section.

1.2 DESCRIPTION OF WORK:

- A. The extent of general site requirements is shown on drawings and specified herein, including but not limited to:
  - 1. Site work general requirements.
  - 2. Protection of Landscaping.
  - 3. Traffic control.
  - 4. Construction Survey (Site work).
  - 5. Protection of utility systems.
  - 6. Construction water and power supply (Site work).
  - 7. Historical preservation.
  - 8. Material Testing (Site work).

1.3 LIMITATIONS:

- A. Owner assumes no responsibility for actual condition of existing structures and utilities crossing, and/or adjacent to this project. It shall be the sole responsibility of the Contractor to be protected all structures and utilities in place.

1.4 QUALITY ASSURANCE:

- A. Codes, standards, and regulations referenced herein.
- B. Work within the public right-of-way shall conform to the rules and regulations of the City of Albuquerque (COA). All such work shall be subject to the inspection and acceptance of the work by the City. The Owner will assist the Contractor with obtaining all required permits.

1.5 RELATED WORK SPECIFIED ELSEWHERE:

- A. Division 1 GENERAL REQUIREMENTS
- B. Division 2 SITEWORK
- C. City of Albuquerque Standard Specifications and Details for Public Works Construction (latest Edition) hereafter referred to as COA.

1.6 SUBMITTALS:

- A. Traffic control plans for each sequence of the construction.

- B. Copy of all permits, inspection forms, and correspondence with the City of Albuquerque.
- C. Support and bracing details for the support of existing utilities, tunnel, vaults and structures that are affected by construction activities.
- D. Construction survey cut sheets and as-built information.

## PART 2 PRODUCTS

Not applicable

## PART 3 EXECUTION

### 3.1 PERMITS

- A. The Contractor shall obtain all required permits. The Contractor shall comply with all provisions of the permits and comply with all governing Federal, State, and Local regulations pertaining to environmental protection.

### 3.2 SITEWORK – GENERAL REQUIREMENTS:

- A. Removal of existing improvements and obstructions shall conform to Section 02100 – SITE DEMOLITION.
- B. Blasting and the use of explosives shall not be permitted on the site.
- C. Conduct demolition, stockpiling and removal operations to ensure minimum interference with roads, streets, sidewalks, bike lanes, other adjacent facilities, and landscaping.
- D. Do not close or obstruct streets, walks or other occupied or used facilities without permission from the Owner and/or the City of Albuquerque.
- E. Protect adjacent structures, improvements, and landscaping from damage caused by demolition and other construction operations. Provide interior and exterior shoring, bracing, or support to prevent movement, settlement or collapse of structures to be demolished or modified, and adjacent facilities to remain. The Contractor, at their sole expense, shall repair all adjacent structures and improvements that are damaged to the satisfaction of the Owner.
- F. The removal limits indicated on the drawings indicates the minimum removal limits. Should construction activities damage additional areas of surfacing, the edge of the surfacing shall be cut back, beyond the limit of damage as directed by the Owner.
- G. When asphaltic concrete (AC) pavement removal is within three (3) feet of an existing curb or edge of pavement, or other structure, remove pavement back to the existing curb line or edge of pavement.
- H. Sidewalk removal shall extend to the nearest joint or edge in the existing sidewalk. Partial removal of sections of sidewalk slabs shall not be accepted. When curb, or curb and gutter removal limits are within three (3) feet of an existing edge, contraction joint, or expansion joint, removal shall extend to the existing edge or joint.
- I. In sidewalks and rigid pavements, sawcut the sidewalk or pavement in such a manner that will facilitate the replacement of the pavement matching the existing joint pattern.
- J. Chain link fence shall be erected at Construction Limits. Fence shall be locked at all gates when work is not in progress.

### 3.3 DUSTCONTROL:



- A. Use water sprinkling and other dust palliative method to limit dust and dirt rising and scattering into the air to lowest practical level. All costs associated with claims and complaints for dust and debris damage and nuisance to people or property shall be borne solely by the Contractor.
- B. Do not use or apply water, or other dust palliative technique, in such that it may create hazardous or objectionable conditions such as ice, flooding, and/or stormwater pollution.

3.4 DISPOSAL OF DEMOLISHED AND EXCESS MATERIALS:

- A. Promptly remove all debris, rubbish, excess materials and other materials resulting from demolition operations from the site. Do not permit debris and rubbish to accumulate on the site
- B. Burning of materials shall not be permitted on site.
- C. All materials not scheduled to be salvaged shall become the property of the Contractor.
- D. Dispose of all materials in accordance with all governing regulations.
- E. Items of salvageable value to Contractor, which have not been identified for salvage by the Owner may be removed as, work progresses. Salvaged items shall be transported off-site as they are removed.

3.5 SALVAGE MATERIALS:

- A. Salvaged materials and equipment, other than landscaping and landscape surfacing, shall be disassembled and removed only at connections. No field cutting shall be permitted without written approval of the Owner.
- B. The Contractor shall protect the salvaged equipment from damage and store all items in such a manner as to protect the items from damage and vandalism. The Contractor shall replace all damaged items.

3.6 PROTECTION OF LANDSCAPING:

- A. The Contractor shall be responsible to protect all trees and shrubs located adjacent to the construction area. Existing trees/shrubs subject to construction damage shall be fenced, or otherwise protected before any work is started. The method of protection and the dimensions of the protection devices shall be determined by the University's Grounds Department in conjunction with the Contractor. Once installed, fencing or other protection device shall be removed without prior approval of the Owner, and there shall be no construction activity or material storage within the fenced areas.
- B. Small trees and shrubs, as determined by the Owner, shall be fenced in such a manner as to encompass the entire drip line area of the tree. In no case shall the enclosure be less than 66% of the radius of the canopy from the trunk of the tree or two (2) feet from a shrub.
- C. Medium and large trees shall be fenced in a manner determined by the University Grounds Department based on sound arboricultural practices. In no case shall the protective device be closer than 66% of the radius of the canopy from the trunk of the tree except in those portions bordered by a street or roadway, in which case the protective device shall be offset one (1) foot from the edge of pavement or back of curb.
- D. When trimming or pruning of trees and shrubs is required, the Contractor shall coordinate all such requirements with the owner two weeks in advance. The University Grounds Department shall carry out all trimming and pruning of trees and shrubs.
- E. Promptly report all damages to trees and shrubs to the Owner. The University Grounds

Department will review the damage and recommend repairs or replacements.

- F. In the event any tree or shrub outside the construction area, or indicated on the plans to remain, is damaged by construction activities, and the Owner determines that it should be replaced, the Contractor shall remove the tree or shrub. The University Grounds Department shall replace the tree or shrub at the sole cost of the Contractor.

3.7 JOB SITE SAFETY:

- A. It shall be the Contractor's sole responsibility to ensure safety within, and adjacent to the construction site.
- B. The Contractor shall install all barriers and traffic control devices to protect the safety of the site and areas adjacent to the site. Refer to paragraph TRAFFIC CONTROL for additional requirements. All excavations and slope banks shall be barricaded to protect the safety of pedestrians and vehicular traffic.
- C. The contractor shall comply with all O.S.H.A. safety rules and requirements, including working within confined spaces.
- D. The contractor shall be solely responsible for the design, installation, and maintenance of all shoring and bracing.

3.8 TRAFFIC CONTROL:

- A. Coordinate the following requirements with Section 01570 - TRAFFIC REGULATIONS.
- B. The requirement of the traffic control for this project is to provide safe and continued pedestrian, bicycle, and vehicular circulation around the construction site with minimize adverse impact on the campus activities and the community.
- C. The Contractor shall be responsible to prepare a traffic control plan acceptable to the Owner, and install and maintain all traffic control devices required during construction. Devices installed within the public right-of-way shall be reviewed and approved by the City of Albuquerque. The Contractor shall obtain the City of Albuquerque approval of all traffic control plans that impacts public streets. When the project is phased, the traffic control plans shall clearly indicate the specific devices installed during each phase or construction.
- D. All traffic control devices shall conform to the "Manual of Uniform Traffic Control Devices" (MUTCD), 2000 Edition; the City of Albuquerque Standard Specifications for Public Works Construction (latest edition); and the requirements specified herein and indicated on the drawings.
- E. All traffic control plans shall be submitted for review a minimum of three weeks prior to the erection of the devices.
- F. All traffic control devices shall be subject to the Owner's review in the field. The Owner reserves the right to monitor the actual performance on the installed traffic control devices and require modifications to facilitate activities on and around the site. The Contractor shall modify the traffic control plans and devices as directed by the Owner.
- G. Do not close or obstruct streets, walks, bike lanes or access to facilities without the approval of the Owner. The Contractor shall request approval of all such closures a minimum of 72 hours prior to the scheduled closure. When streets, sidewalks, bike lanes or access is restricted, provide alternate routes (detours) around closed or obstructed traffic ways.
- H. Signage for street, bike lane and sidewalk closure, detours, shall be equipped with a sub-panel that describes the work in progress and the appropriate detour. The specific wording on the sub-panel shall be reviewed as part of the traffic control plan submitted by the Contractor.

- I. All placement of signage within landscape areas shall be coordinated and approved by the University Grounds Department.
- J. To maintain pedestrian traffic around the site, and to adjacent facilities, the Contractor shall construct all required temporary sidewalks, and curb ramps. All temporary facilities shall be capable of supporting all loads, have a non-slip surface, and shall comply with ADA accessibility standards. Ramps shall not have any vertical lip greater than ¼-inch and a longitudinally slope of less than 1-foot vertical to 12-feet horizontal. The cross slope of temporary facilities shall not exceed 2 percent. The minimum width of pedestrian detours shall be 6-feet.
- K. Barriers and traffic control devices shall be adequate for visually impaired pedestrians. Barricades and fencing shall be equipped with toe-kicks. Toe-kicks shall be a minimum of 3-inches in height and be installed the base of the barricade or fence at all locations where the fence or barricade crosses or runs parallel to a logical walkway.
- L. The site and off-site excavations shall be enclosed within a six (6) foot high chain link fence. The fence shall restrict all unauthorized entrances into the work area and shall be anchored to the ground. The location of the fencing shall be approved by the Owner and shall be placed to minimize the disruption to pedestrian and vehicular traffic. During construction the Contractor shall monitor open gates to prevent unauthorized entrances into the work area. When work is not in process, all gates shall be closed and locked.
- M. The Contractor shall provide flag personnel as required to guide construction vehicles into and out of the fenced construction area.
- N. At the completion of the construction, all temporary detours, ramps, pavement, pavement markings, and signage shall be removed and the surfacing restored to its original condition.
- O. The traffic control plans shall clearly indicate the construction haul routes to be utilized during construction.
- P. When traffic control restricts the vehicular circulation within existing parking lots, the traffic control shall delineate with temporary pavement markings and signage all required temporary parking area access lanes to maintain adequate vehicular circulation.

### 3.9 CONSTRUCTION SURVEY – SITEWORKS:

- A. The Contractor shall be responsible for all construction layout and staking of the driveways, pavement areas, sidewalks, and utility lines.
- B. All layout and staking shall be carried out under the direction of professional land surveyor, registered in the State of New Mexico.
- C. The Surveyor shall prepare cut sheets and shall submit copies to the owner showing all stationing and cuts for the pipelines, valves, fittings, grade breaks, curbs, curb returns, pavement grades etc. to be included in the proposed system. Stationing and grades shall be on the same datum as the design drawings.
- D. Construction staking shall reflect the information shown on the cut sheets. Stationing, cuts, offset distance, and direction (N, S, E, or W) shall be shown on the grade stakes.
- E. Off-set hubs shall be set far enough from the trench or new construction to avoid being lost during excavation. Lost or damaged staking shall be replaced at the Contractor's expense.
- F. Grade stakes, blue-tops, and hubs shall be installed at sufficient frequency to permit for adequate control on the project.

- G. It shall be the responsibility of the Contractor to protect all existing survey monuments. The Contractor shall replace all survey monuments disturbed by the construction.
- H. The Surveyor shall notify the Owner of all discrepancies found in the field as soon as they are discovered.
- I. The Surveyor shall prepare as-built notes indicating the elevations and locations of the constructed improvements and utilities, including, valves, fittings, grade breaks, etc. The as-built survey information shall be transposed onto the as-built drawings.

3.10 PROTECTION OF EXISTING UTILITIES:

- A. It shall be the responsibility of the Contractor to contact the New Mexico ONE-CALL (1-800-260-1990) and the University of New Mexico a minimum of seven working days prior to the commencement of any excavating operations. The Contractor shall record and maintain all utility locating markings and coordinate any and all re-markings of the utilities that may be required.
- B. The utilities locations indicated on the drawings were compiled based on the best available information. However, the utility locations are not considered to be exact or complete. Prior to commencing work, the Contractor shall verify the horizontal and vertical location of all utilities with the appropriate organization and. If necessary, pothole all utility lines whose exact horizontal or vertical location is in question.
- C. It shall be the responsibility of the Contractor to protect all existing utilities "in-place" unless specifically noted otherwise in the contract documents. The Contractor shall install all temporary supports required to protect utilities and structures crossing, or adjacent to the excavations required to prevent their movement or settlement. All temporary supports shall be capable of resisting all horizontal and vertical forces within, and acting on, the utility or structure.
- D. Any work performed above, below or in the tunnel system, existing utility systems and structure should be protected from any form of damage. Construction equipment and materials shall not be driven, placed or stored on the tunnel cap without providing a PE stamped drawings form a structural engineer that will provide appropriate safeguards to protect the integrity of the tunnel cap.
- E Any penetrations to the tunnel system shall be protected from the weather, animals, flooding, and illegal entry at the end of each day until the tunnel is permanently sealed.
- F. Do not interrupt any utilities, except when authorized by the Owner. When required, provide temporary services during interruptions to existing utilities. The cost associated with temporary utilities shall be included in the bid price.
- G. In the event that the Contractor damages an existing utility line, the Contractor shall immediately contact the University of New Mexico and the utility owner to report the incident.
- H. The Contractor shall promptly repair the damaged utility to the satisfaction of the utility owner.
- I. The repair of all damage to utility lines shall be subject to the specifications and inspection of the utility owner. The cost of all utility repairs shall be the sole responsibility of the Contractor.

3.11 WORK WITH THE PUBLIC RIGHT-OF-WAY:

- A. All work within the public right-of-way shall be covered under an agreement between the University and the City of Albuquerque. All work covered by this agreement shall be subject to the inspection and acceptance by the City.

3.12 CONSTRUCTION WATER AND POWER SUPPLY:

- A. The Contractor shall coordinate construction water service from either the UNM PPD Utilities Division or the City of Albuquerque. The construction water service from the UNM water system shall be equipped with all backflow prevention equipment as specified in section 02719 Water System.
- B. The UNM Utilities Division will provide the construction water meter and will be responsible for the cost of the water used. The Contractor shall be responsible for installing, protecting, and returning the meter to UNM. The Contractor shall be responsible for the loss of the meter or any damage to the meter.
- C. The Contractor shall coordinate construction electric service with the UNM PPD Utilities Division. The construction electric service from the UNM system shall be designed to protect the integrity of the UNM electric system in the event of a fault or other anomaly in the construction site electric system. The construction electric service shall only be connected to the UNM system by UNM Utilities Division electricians and only after the system has been inspected and approved the UNM Utilities Division electricians.
- D. The UNM Utilities Division will provide the construction power meter and will be responsible for the cost of the power used. The Contractor shall be responsible for installing, protecting, and returning the meter to UNM. The Contractor shall be responsible for the loss of the meter or any damage to the meter.

3.13 HISTORICAL PRESERVATION:

- A. The Contractor shall protect all historical features adjacent to construction site. Historical features within this area of the campus include Historically significant buildings, landscapes, and places or objects that possess exceptional value of quality in representing and reflecting the architecture and cultural heritage of the University, and specimen species of trees.

3.14 MATERIAL TESTING SITE WORKS:

- A. The Contractor shall be responsible for all material testing associated with material submittals and their approvals.
- B. The Owner will engage a testing agency to perform material testing on the completed work or portions thereof. The Contractor shall provide the Owner with an adequate schedule to allow the Owner to coordinate all such testing. The Contractor shall provide adequate access to the site to the testing agency. The test conducted on behalf of the Owner shall not relieve the Contractor of any contractual obligation to construct the project in accordance with the contract documents. The Contractor may elect to perform additional testing at their sole expense. Copies of all additional testing shall be provided to the Owner.
- B. All costs associated with the re-testing of materials that have failed prior testing shall be the sole responsibility of the Contractor.
- C. The frequency and type of material testing shall be at the sole discretion of the Owner.

3.15 DOCUMENTATION OF EXISTING CONDITIONS:

- A. Prior to the start of the construction, the contractor shall take photographs of the existing conditions of the area adjacent to the construction site. The photographs shall clearly show the existing conditions of the site and the areas adjacent to the site. Copies of the photographs shall be submitted to the Owner.

END OF SECTION

SECTION02221

EXCAVATION, TRENCHING AND BACKFILLING  
FOR UTILITIES SYSTEMS

PART 1 GENERAL

1.1 RELATED DOCUMENTS:

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification sections apply to work of this Section.

1.2 DESCRIPTION OF WORK:

- A. Work as evident on drawings and specified herein or required to accomplish the designated excavation, trenching, bedding, shading, and backfilling for utilities systems.
- B. Excavation shall include the removal of all materials encountered, and the removal of all debris, unsuitable material, and excess excavated material from the site.

1.3 UTILITY IDENTIFICATION:

- A. It shall be the responsibility of the Contractor to contact the New Mexico ONE CALL (1-800-260-1990) and the University of New Mexico a minimum of seven working days prior to the commencement of any excavating operations. The Contractor shall record and maintain all utility locating markings and coordinate any and all re-markings of the utilities that may be required.
- B. The Contractor shall verify the location of all underground utilities with the appropriate organization and protect all utility lines in-place as specified herein.

1.4 QUALITY ASSURANCE:

- A. Codes, standards, and standard details referenced herein, and all governing rules and regulations applicable to this work.
- B. City of Albuquerque Standard Specifications and Details for Public Works Construction, (latest edition) referred to herein as COA.

1.5 PROTECTION OF EXISTING UTILITIES:

- A. It shall be the responsibility of the Contractor to protect all existing utilities "in-place" unless specifically noted otherwise in the contract documents. Existing utilities crossing any excavation shall be supported and protected against damage. The supporting system shall be capable of restraining all dead and live loads acting on the utility.

- B. All utilities whose exact horizontal or vertical location is not determined in the field, shall be pot holed to determine its exact horizontal and vertical location. Pot holing operations shall be carried out significantly in advance of the pipe laying operations to facilitate any required alignment modifications. The work associated with pot holing operations shall locate all utilities both horizontally and vertically and determine the material of the existing utility. The cost of pot holing activities shall be included in the contract price.
- C. The Contractor shall prepare, and submit, details of the methods to be utilized to support utility lines crossing, and abutting, the trench or excavation. The detail shall clearly show the techniques that will be used to support the utility lines both horizontally and vertically.  
  
At crossings of utility tunnels, special attention shall be given to tunnel sections containing expansion joints. If existing expansion joints are located within, or within 2-feet of the limits of trenching, the tunnel sections shall be fully supported across the trench. At such locations, the supporting system shall be capable of supporting the full loading of the tunnel system.
- D. If any utility lines or portion thereof, are damaged by construction activities, the Contractor shall immediately notify the appropriate Utility Company and the Owner. Any reinstallation and/or repair of the utility shall be as directed by the utility owner and all costs associated with the reinstallation or repair shall be borne by the Contractor.
- E. When approved in writing by the Owner of the existing utility, existing utility lines may be temporarily removed to facilitate the installation of the new utility system. When such action is taken, the reinstatement of the existing utility shall be in accordance with the requirements of the utility company and these specifications, whichever is more stringent. The cost of such work, and all work associated with maintaining the existing utility during the temporary removal shall be included in the contract price.

1.6 RELATEDWORK SPECIFIED ELSEWHERE:

- A. Section 02060: GENERAL SITE REQUIREMENTS.
- B. Section 02210: SITE SURFACING IMPROVEMENTS.
- C. Section 02270 TEMPORARY EROSION CONTROL.
- D. Section 02560: SANITARY SEWER SYSTEM.
- E. Section 02580: STORM SEWER SYSTEM.
- F. Section 02718: DIRECT BURIED CHILLED WATER SYSTEM AND COOLING TOWER CONNECTION PIPING.
- G. Section 02719: WATER SYSTEM
- H. Section 02720: UNDERGROUND CHILLED WATER PIPING INSULATION.
- I. Section 02990: PRECAST STEAM TUNNEL.
- J. Division 15: MECHANICAL SYSTEMS.
- K. Division 16: ELECTRICAL SYSTEMS.
- L. City of Albuquerque Standard Specifications and Details for Public Works Construction, latest edition, hereafter referred to as COA.

1.7 SAFETY:

- A. The Contractor shall adhere to all O.S.H.A. requirements.
- B. The Contractor shall be responsible for the design, installation and maintenance of all required shoring, blocking and bracing. Shoring shall be installed at all locations where sloping the trench/excavation banks will adversely impact existing improvements, utilities, construction access, and/or site circulation whether specifically noted on the drawings or not.

1.8 MATERIAL TESTING:

- A. All material testing associated with submittal process to obtain approval of such material shall be the responsibility of the Contractor, and all costs associated with said tests shall be borne by the Contractor.
- B. The field testing of installed work shall be conducted by a material testing firm at the cost, and on the behalf, of the Owner. The testing conducted on behalf of the Owner shall not relieve the Contractor from meeting the requirements of the contract documents. The cost of re-testing shall be borne by the Contractor.
- C. The Contractor shall provide adequate notification to the Owner's Representative to allow the Owner to schedule the required field testing and sampling. Failure on the Contractor's part to provide adequate notification shall not be cause for claiming delays or justification to backfill or cover work prior to testing. The Contractor shall provide the material testing firm with adequate access to, and around the site, and shall provide all required labor to obtain samples of the materials.
- D. The Owner and the materials testing firm will strive to notify the Contractor of the results of the testing in a prompt manner. However, should work progress prior to receipt of the test results, it shall remain the responsibility of the Contractor to correct all defective work noted by the test result(s).

1.9 SUBMITTALS:

- A. Imported Material: Submit laboratory results of the characteristics for each imported material proposed to be used. The material characteristics shall include; PH, plasticity index, liquid limit, gradation, and the source for each imported material.
- B. Detail for the support of existing utilities.

PART 2 PRODUCTS

2.1 BEDDING AND SHADING MATERIAL:

- A. Bedding and shading material shall consist of the material located around the pipe from the bottom of the trench (6 inches minimum below the invert of the utility) to an elevation of 12-inches above the top of the utility.
- B. Select Material: Select material shall be native or imported material which is free of stones larger than 2 inches in diameter, construction debris, chunks of clay, and other deleterious material. The material shall comply with the following:

<u>Sieve Size</u>	<u>Percent Passing by Weight</u>
2 inch	100
3/4 inch	60 - 100
No. 8	35 - 80
No. 200	(1)

(1) The sum of the percent passing the No. 200 sieve and the plasticity index (PI) shall not exceed 25.



C. Sand: Sand shall conform to the following:

<u>Sieve Size</u>	<u>Percent Passing by Weight</u>
1 inch	100
No. 4	60 - 100
No. 200	0 - 5
Max PI = 5	
Max LL = 30	

2.2 PERMITTED USE OF BEDDING AND SHADING MATERIAL:

A. The bedding and shading material used around new and existing utility lines shall be as follows:

1. Insulated Piping: Sand
2. Ductile Iron Pipe (DIP): Select material or sand.
3. Polyvinyl Chloride (PVC) Pipe: Sand.
4. Concrete Cylinder Pipe (CCP): Select material or sand.
5. High Density Polyethylene (HDPE): Sand
6. Reinforced Concrete Pipe (RCP): Select material or sand.
7. Vitrified Clay Pipe (VCP): Sand.
8. Steel Pipe with Coating: Sand.
9. Electric and Communications Ducts: Concrete encasement or sand matching the existing conditions. All concrete encasement shall match the color of the existing encasement.

B. Bedding, shading, and backfill around public water lines shall conform to City of Albuquerque Standard Specifications and Details for Public Works Construction.

C. Bedding, shading, and backfill around public sewer lines shall conform to City of Albuquerque Standard Specifications and Details for Public Works Construction.

2.3 BACKFILL MATERIAL:

A. General: Backfill shall extend from the top of the bedding and shading to the design subgrade elevation for pavements or to the depth of the topsoil within landscape areas.

B. Native Soils: Native soil which is free of construction debris, organic material, deleterious materials, and stones larger than 4 inches in diameter, or the depth of the compacted lift. The backfill material shall have an adequate gradation to ensure proper compaction densities.

2.4 SHORING:

A. All shoring materials shall be capable of supporting all soil loads and induced loading.

B. The design of all shoring and materials used for shoring shall be the sole responsibility of the Contractor.

C. Shoring shall be designed, installed, and maintained in such a manor as to not induce

excessive loading on existing utilities or structures.

2.5 UTILITY MARKING TAPE:

- A. Utility marking tape shall be acid and alkali-resistant polyethylene film 6 inches wide with minimum thickness of 0.004 inch. Tape shall have a minimum strength of 1750 psi lengthwise and 1500 psi crosswise. The tape shall be manufactured with integral wires, foil backing, or other means to enable detection by a metal detector when the tape is buried up to 3 feet deep. The tape shall be of a type specifically manufactured for marking and locating underground utilities. The metallic core of the tape shall be encased in a protective jacket or provided with other means to protect it from corrosion. Tape color shall be as specified in TABLE 1 and shall bear a continuous printed inscription (black lettering) describing the specific utility.

TABLE 1

<u>Utility</u>	<u>Color</u>	<u>Printed Inscription</u>
Chilled Water	Purple	"Caution Chilled Water Lines -Do Not Drink"
Communications	Orange	"Caution Communication Lines"
Potable Water	Blue	"Caution Water Lines Below"
Gas	Yellow	"Caution Gas Lines"
Electric	Red	"Caution Electric Lines"
Sanitary Sewer	Green	"Caution Sanitary Sewer"
Storm Sewer	Green	"Caution Storm Sewer"
Fire Service	Blue	"Caution Fire Service"

2.6 CONCRETE ENCASMENT:

- A. Concrete shall be 2,500 PSI at 28 days meeting the requirements of COA Standard Specification Section 101. Color of encasement of electric ducts shall be red.

2.7 GRAVEL TUNNEL DRAIN:

- A. Gravel shall be crushed stone that is free of construction debris, chunks of clay, other deleterious material, and excessive fines. The material shall comply with the following gradation:

<u>Sieve Size</u>	<u>Percent Passing by Weight</u>
1/2 inch	100
3/8 inch	90 - 100
No. 4	75 - 90
No. 16	0 - 10

PART 3 EXECUTION

3.1 LAYOUT:

- A. The Contractor shall hire a land surveyor, registered in the State of New Mexico, who shall be responsible to stake, horizontally and vertically, the utility systems. Refer to Section 02060 – GENERAL SITE REQUIREMENTS for additional requirements.

3.2 TRAFFIC CONTROL:

- A. The Contractor shall prepare a traffic control plan and install all required traffic control devices. Refer to Section 02060 – GENERAL SITE REQUIREMENTS for additional requirements.

3.3 DUST CONTROL:

- A. The Contractor shall obtain all required "Air Quality Permits" and be responsible for dust control on the project. Refer to Section 02060 – GENERAL SITE REQUIREMENTS for additional requirements.

3.4 BLASTING:

- A. Blasting and use of explosives shall not be permitted.

3.5 PROTECTION OF EXISTING UTILITIES:

- A. It shall be the responsibility of the Contractor to protect all existing utilities "in-place" unless specifically noted otherwise in the contract documents.
- B. Utility lines, including concrete trench caps, shall be protected and supported at crossings. The supports shall protect the utility lines from all objectionable deflection and be capable of restraining all forces acting on the utility line. Refer to Section 02060 – GENERAL SITE REQUIREMENTS for additional requirements.
- C. Gas Lines: No uncased PVC, PE, or other non-metallic gas line shall be left exposed at any time when work is not in progress. Should the construction procedures require such a line to remain exposed during non-working hours, the Contractor shall notify Public Service of New Mexico who shall either sleeve the line or reinstate the line using metallic piping.
- D. Bedding, shading, and backfilling around existing utilities shall match the existing or as specified herein, whichever is more stringent.
- E. All street and area lights shall remain in operation unless approved in writing by the Owner of said lights or indicated on the drawings.

3.6 EXCAVATION:

A. General:

1. The provisions of COA Standard Specification Section 700 shall be adhered to except as modified herein.
2. Perform all excavations to the depths indicated or specified. During excavation, stockpile material suitable for backfill in a neat manner and sufficient distance from the trench to avoid slides and cave-ins.
3. All excavated materials not required or suitable for backfill shall be removed and wasted as indicated or as directed at the Contractor's sole expense. Grade as required to prevent surface water from flowing into trenches or other excavations. Remove any accumulated water by pumping or other approved method.
4. Place shoring as necessary for the protection of the work and safety of personnel. Sheeting and shoring shall conform with all O.S.H.A. regulations.
5. Around existing structures and utility lines, excavation shall be sufficiently off-set to avoid undermining the structure or utility.
6. All processing of material including screening, mixing, or other related work shall be carried out in such a manner as not to create a nuisance to the adjacent property owners or to pedestrian/ vehicular traffic in the vicinity.

- B. Trench Excavation: Trenches shall be of the necessary width for proper installation of utility systems. The sides of pipe trenches shall be as nearly vertical as practicable. Care shall be

taken not to overexcavate. The bottom of the trenches shall be accurately graded to the design grade, avoiding high points between points of grade changes. The trench shall provide uniform bearing and support for each section of the pipe at every point along its entire length, except at bell holes and for the proper installation of joints. Bell holes and depressions for joints shall be dug after the bedding has been graded. Bell holes and depressions shall be only of such length, depth, and width as required for properly making the particular type of joint. Stones shall be removed as necessary to avoid point bearing.

Except as hereinafter specified for wet or otherwise unstable material, overdepths shall be backfilled and compacted with select material. Whenever wet or otherwise unstable material that is incapable of properly supporting the pipe is encountered in the bottom of the trench, such material shall be overexcavated to a depth to allow for construction of a stable pipe bedding. The trench shall be backfilled and compacted to the proper grade with select materials.

1. Chilled Water Lines: The width of the trench at and below the top of the pipe shall be such that the clear space between the barrel of the pipe and the trench wall is as shown on the plans. The width of the trench above that level shall be as wide as necessary for sheeting and bracing and the proper performance of the work. The bottom of the pipe shall rest firmly on bedding material for as nearly the full length of the barrel as proper jointing operations will permit.
2. Potable Water Lines: Unless otherwise indicated, trenches shall be graded to avoid high points and the necessity of placing vacuum and air relief valves in the water lines. Trenches shall be of a depth indicated on the plans and to avoid interference of the waterlines with other utilities.
3. Storm and Sanitary Sewers: The width of the trench at and below the top of the pipe shall be such that the clear space between the barrel of the pipe and the trench wall is as shown on the plans. Grade bedding material to provide the design slopes.
4. Mechanical Systems: Per Division 15.
5. Electrical Systems: Per Division 16.

3.7 REMOVAL OF UTILITY LINES:

- A. Refer to Section 02060 – GENERAL SITE REQUIREMENTS for additional requirements. Record capped or plugged utility locations on as-built drawings.

3.8 BEDDING, SHADING AND BACKFILLING:

- A. Place bedding material as specified and as indicated on the plans, grade and compact material to the design grade. Excavate bell holes as required. The Contractor shall protect the installed bedding from damage due to construction operations and excess moisture. All bedding material which is adversely damaged shall be repaired by the Contractor to the satisfaction of the Engineer.
- B. Coordinate shading operations with the requirements for insulation, polyethylene encasement and pipeline testing. Shading material shall be deposited in 6 inch layers maximum and compacted with suitable tampers to the density as hereinafter specified until there is a cover of not less than 1 foot over the utility lines. The material in this portion of the trench shall be the type of material specified for the specific utility line and at a moisture content that will facilitate compaction. Take special care not to damage the insulation, coating or wrapping of pipes.
- C. Backfill the remainder of trench, except for special materials for pavements, base course, Top soil, Cornell soil mix for trees, etc. Backfill material shall be deposited in layers not exceeding 8 inches compacted thickness, and each layer shall be compacted to the

minimum density specified as applicable to the particular area. Settling of granular, noncohesive material with water will not be permitted. Degree of compaction shall be as follows, expressed as a percentage of the maximum density obtained by the test procedure presented in ASTM D 698.

3.9 COMPACTION:

A. All material shall be compacted to the following specified percent of the maximum density as determined by ASTM D1557.

1. Bedding and shading 90% minimum.
2. Backfill material 95% minimum.
3. Top 8" of landscape areas 80-83%

3.10 UTILITY MARKING TAPE:

A. Marking tape(s) shall be installed directly above each utility line at a depth of 18 inches below finish grade unless otherwise shown. When the utility line width exceeds the marking tape width, two tapes shall be installed, one above each side of the line.

B. At utility crossings, reinstall or replace tapes above existing utilities per the utility owner's requirements, and as specified above.

END OF SECTION

SECTION 02270

TEMPORARY EROSION CONTROL

PART 1 GENERAL

1.1 RELATED DOCUMENTS:

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work of this section.

1.2 DESCRIPTION OF WORK:

- A. The Contractor shall prepare an erosion control plan for the construction site in accordance with the parameters indicated herein, on the drawings, required by governing regulations. The contractor shall install and maintain all erosion control devices indicated on the approved plan or as required to prevent stormwater runoff from the site from polluting downstream waters. Work includes, but not limited to:
  - 1. Perimeter silt fences and control devices.
  - 2. Erosion control around new and existing storm drain inlets.
  - 3. Control for tracking of soil and other materials on adjacent streets, sidewalks and roadways.
- B. Due to previous construction activities on the site, there is some temporary erosion control devices installed on the site. If the Contractor elects to use the existing devices, they shall assume full responsibility for the maintenance and removal of the devices. If the Contractor elects not to use the existing temporary erosion control devices, the Contractor shall remove the existing devices.

1.3 LIMITATIONS:

- A. It shall be the sole responsibility of the Contractor to install and maintain all required erosion control devices and to comply with all governing regulations.

1.4 QUALITY ASSURANCE:

- A. Codes, standards, and regulations referenced herein.

1.5 RELATED WORK SPECIFIED ELSEWHERE:

- A. Section 02060: GENERAL SITE REQUIREMENTS.
- B. Section 02100: SITE DEMOLITION.
- C. Section 02110: CLEARING AND GRUBBING.

- 1.6 SUBMITTALS:
  - A. Erosion control plans sequence of the construction phasing.
  - B. Erosion Control devices, including silt fence, straw bales, construction rock vehicle tracking pad, and other devices
- 1.7 REGULATORY REQUIREMENTS
  - A. Comply with all governing regulatory requirements.
  - B. Contractor shall be responsible for preparing plans, reports, and monitoring required by regulatory agencies and the construction documents.

PART 2 - PRODUCTS

- 2.1 SILT FENCE
  - A. Provide silt fence with reinforced backing and staking materials. Silt fence shall be suitable to filter sediment out of the stormwater.
  - B. Silt Fences shall be Mirafi Envirofence 10550, Mirafi Siltfence 10800 or approved equal.
- 2.2 STRAW BALES
  - A. Straw bales shall be standard 36" x 24" x 18" bales.
  - B. Stakes shall be steel posts capable of anchoring the straw bales in-place.
- 2.3 CONSTRUCTION ROCK VEHICLE TRACKING PAD
  - A. Crushed rock forming a pad with a minimum thickness of six inches, the rock shall be between 1-1/2 and 3 inches gradation.

PART 3 - EXECUTION

- 3.1 TIMING
  - A. Install all required temporary erosion control devices prior to grubbing and rough grading of the site.
  - B. Maintain all temporary erosion control devices in-place until site is landscaped (placement of final surfacing).
- 3.2 SILT FENCE
  - A. Set posts 4 foot outside the perimeter of the inlet.
  - B. Excavate a 4 inch x 4 inch trench upslope long the line of posts.
  - C. Install fabric, fabric shall extend a minimum of 24 inches above finish grade.
  - D. Backfill and compact excavated trench.
  - E. Follow manufacturer's installation guidelines for attaching the silt fence to the post.
  - F. Repair, replace all damage to the fences as soon as it occurs.

3.3 STRAW BALES

- A. After tilling the soil for bonding of topsoil with the subsoil, spread the topsoil evenly to a minimum depth of 6 inches. Incorporate topsoil at least 2 to 3 inches into the subsoil to avoid soil layering. Do not spread topsoil when frozen or excessively wet or dry. Correct irregularities in finished surfaces to eliminate depressions. Compact topsoil to between 83 to 87 percent of the maximum density as determined by ASTM D 698. Protect finished topsoil areas from damage by vehicular or pedestrian traffic.

3.4 CONSTRUCTION ROCK VEHICLE TRACKING PAD

- A. At all construction access points to paved roadway a construction rock vehicle tracking pad shall be constructed.
- B. The pad shall be a minimum of 10 feet wide by 24 feet long. All vehicles entering and exiting the site shall be required to pass over the pad.
- C. Grade area of the pad 4 inches below finish grade. Place rock to provide a minimum thickness of 6 inches.
- D. Should the rock vehicle tracking pad be determined not to be sufficient to minimize dirt and mud from being tracked onto existing roads, the Owner shall require the Contractor to install a vehicle wheel wash. The wheel wash shall be located at the tracking pad, and it shall be the sole responsibility of the Contractor to provide all water, equipment, and labor required for the wheel wash.

3.5 MAINTENANCE

- A. The Contractor shall be responsible for maintaining temporary erosion control devices throughout project.
- B. Remove and replace straw bales that have become sediment laden and ineffective.
- C. Remove and replace silt fence that has become damaged, sediment laden, and/or ineffective.

3.6 CLEAN UP

- A. When approved by the Owner, remove all temporary erosion control provisions. Fill all trenches and excavations and reinstate the surfacing to the satisfaction of the Owner.

END OF SECTION



SECTION02718

DIRECT BURIED CHILLED WATER SYSTEM AND COOLING TOWER CONNECTION PIPING

PART 1 GENERAL

1.1 RELATED DOCUMENTS:

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification sections apply to work of this section.

1.2 DESCRIPTION OF WORK:

- A. The extent of underground chilled water (CHW) piping system and underground cooling tower connection (CTC) piping shown on drawings, including site piping and piping under buildings and cooling towers. The piping work includes, but is not limited to, the following:
  - 1. Piping and fittings.
  - 2. Valves, and valve boxes.
  - 3. Joint restraint devices.
  - 4. System Testing.

1.3 LIMITATIONS:

- A. The interconnection between the chilled water piping installed under this project shall be coordinated with the chilled water piping being installed under other projects. Said projects will install pipe north of the plant site and south of the plant. Site as indicated on the drawings.
- B. No connections shall be made to CHW piping installed under other projects until such time that the system has been tested and the Owner approves the connection.
- C. At the points of connection to piping installed by other projects, the off-site piping may be filled with water. Prior to making the connections, the Contractor shall drain the off-site system as required to make the connection, and dispose of all drain-down water. After the final connection is made, the Contractor shall fill and purge the onsite CHW system.
- D. The Owner shall operate all existing valves, the Contractor shall schedule all valve closures, and operation, with the Owner.

1.4 QUALITY ASSURANCE:

- A. The codes, standards, and standard details referenced herein.
- B. Certification by the Contractor stating that the system was installed and tested in accordance with the plans and specifications.
- C. Manufacturer's certification of the pipe and fittings.
- D. The Contractor shall conform to all rules and regulations of the State of New Mexico Department of the Environment.

1.5 IDENTIFICATION:

- A. All components of the chilled water system and cooling tower connection system shall be

marked to indicate that the system is a non-potable water system.

1.6 RELATED WORK SPECIFIED ELSEWHERE:

- A. Section 02060: GENERAL SITE REQUIREMENTS.
- B. Section 02221: EXCAVATION, TRENCHING AND BACKFILLING FOR UTILITIES SYSTEMS.
- C. Section 02720: UNDERGROUND CHILLED WATER PIPE INSULATION.
- D. City of Albuquerque Standard Specifications and Details for Public Works Construction (Latest Edition) hereafter referred to as COA.

1.7 SAFETY:

- A. The contractor shall adhere to all O.S.H.A. and other governing rules and regulations. The interior of existing chilled water lines shall be considered as confined space areas.
- B. Prior to pressurizing the system or any portion thereof, the contractor shall verify that all thrust restraint devices are installed, and the system adequately restrained to prevent movement of the pressurized system.
- C. Air testing of the lines shall not be permitted.

1.8 SUBMITTALS:

- A. Manufacturer's product data and installation instructions for each product specified for the chilled water piping.
- B. Manufacturer's certification for the ductile iron pipe and valves.
- C. Copies of all hydrostatic tests.
- D. Mix design for each class of concrete utilized.

PART 2 PRODUCTS

2.1 DUCTILE IRON PIPE:

- A. General: Provide all piping, fittings, and other required piping accessories required to complete the system.
- B. Ductile Iron Pipe (DIP): All pipe shall be push-on Tyton joint, mechanical joint, TJ joint, or integral restrained joint ductile iron pipe. The pipe shall be manufactured and tested in accordance with the American Water Works Association (AWWA) Standard C151.
- C. Chilled water (CHW) site piping, outside of buildings, shall be Pressure Class pipe, of not less than:

24"-30" dia      Pressure Class 200

- D. Chilled water (CHW) piping and cooling tower connection (CTC) under, and within three feet of, buildings and cooling towers, shall be Thickness Class pipe, of not less than:

24"-30" dia      Thickness Class 53.

Piping under buildings and cooling towers shall be restrained mechanical joint.

- E. Rubber gasket joints shall satisfy requirements of AWWA C111. Flanged ductile iron pipe shall be manufactured in accordance with AWWA C115. Flanges shall be rated for 250 PSI working pressure. The bolt circle and bolt holes shall match those of ASME/ANSI B16.1, Class 125 and ASME/ANSI B16.5 Class 150 flanges. The minimum thickness class for ductile iron pipe to be threaded shall be Class 53.
- F. All ductile iron pipe shall have a standard thickness cement-mortar lining followed by a seal coat of asphaltic material in accordance with AWWA C104.
- G. The exterior surfaces of all ductile iron pipe and fittings shall be coated with a bituminous material in accordance with AWWA C151 before shipment.
- H. Threads for threaded flanged pipe shall be taper pipe threads in accordance with ANSI B2.1, with thread diameters adjusted to conform to ductile iron pipe standard outside diameters.

## 2.2 DUCTILE IRON FITTINGS:

- A. Fittings and specials shall conform to AWWA C110, AWWA C153, and AWWA C111. Fittings and specials shall be cement-mortar lined in accordance with AWWA C104. Linings shall be standard thickness and seal coated with a bituminous material.
- B. The exterior surfaces of all ductile iron fittings shall be coated with a bituminous material in accordance with AWWA C110.
- C. Fittings under buildings and cooling towers shall be restrained mechanical joint.
- D. Fabricated wall pipe shall be Thickness Class 53. The intermediate flange shall not be less than 3/8-inch thick and shall have an outside diameter of not less than 6 1/2-inches larger than the outside diameter of the pipe.

## 2.3 DUCTILE IRON PIPE AND FITTINGS CERTIFICATION:

- A. The manufacturer of the ductile iron pipe and fittings shall issue a certification that states that all pipe, and fittings have been manufactured, tested, lined, and coated in accordance with the project specifications and the reference standards. This certification shall list the names of the manufacturer, the Owner, the General Contractor, and the project.

## 2.4 CONTROL VALVES (OUTSIDE OF PLANT):

- A. Butterfly valves (16" and larger) shall be rubber seated conforming to AWWA C504. The valves shall be designed for direct buried service. The valves shall be supplied with a minimum of 10 mils interior epoxy coating and a 12 mils exterior epoxy coating. Coatings shall conform to AWWA C550 and AWWA C504.
- B. Valves shall have a horizontal shaft, manual actuator, and an AWWA 2-inch square operating nut. Valves shall open counter-clockwise.
- C. Valves shall be rated for a minimum working pressure 250 PSI and be tested and certified by the manufacturer as being bubble tight at 200 PSI.

## 2.5 JOINT RESTRAINT DEVICES:

- A. All joints, fittings, and valves within the limits for joint restraint shown on the drawings shall be fully restrained.
- B. Joint restraint devices shall comply with City of Albuquerque Standard Specification Section 800. Acceptable joint restraint devices include the following, or approved equal:

1. Ductile iron mechanical style joints - EBAA Iron Sales, Inc. "Megalug" joint restraint system, Series 1100.
2. Ductile iron flange connection - EBAA Iron Sales, Inc. "Megaflange" joint restraint flange adapter. The specific model utilized shall be compatible with the type of pipe connected to the fitting.
3. Ductile iron push-on style joints – EBBA Iron Sales Series 1700.
4. Integral ductile iron joint restraint type - U.S. Pipe "TR Flex" or Pacific States "Perma-Loc" restrained joint pipe and fittings.
5. Flanged joint fittings that are within three (3) feet of one another, may be restrained by using the tie rods. The tie rods, bolts, nuts, and couplings shall be constructed of carbon steel conforming to the requirements of ASTM A307, Grade B, and shall be cadmium plated in accordance with ASTM A165 with a minimum plating thickness of 0.0002 inch. If the rods are to be utilized, the Contractor shall submit detailed shop drawings and calculations of the tie rod design, in accordance with DIPRA-01 to the Owner's for review and acceptance
6. Joint restraint devices shall be rated for a minimum working pressure of 250 PSI, with a minimum safety factor of 2:1.
7. Field welding of ductile iron pipe for joint restraint shall not be permitted.

2.6 VALVE BOXES:

- A. Valve box and cover shall consist of a cast iron box and cover and PVC riser as detailed on the drawings. The valve box and cover casting shall be manufactured in conformance with ASTM A48, Class 30B.
- B. Valve stem extensions shall comply with City of Albuquerque Standard Specification Section 801 and as detailed on the drawings.

2.7 AIR RELIEF VALVE VAULTS:

- A. All cast-in-place concrete shall conform to City of Albuquerque Standard Specifications Section 101 (3000 psi).
- B. Reinforcement shall conform to COA Standard Specification Section 103 (Epoxy Coated), Grade 40.
- C. Pre-cast manhole section shall have an inside diameter of 6 feet and conform to the requirements of ASTM C478.
- D. The frame and cover shall be 30 inch diameter, traffic rated (HS20), and have a bolted watertight lid. The frame and cover shall be Neenah Catalog No. R-1916-H or approved equal.

2.8 AIR RELIEF VALVES:

- A. Vacuum and air relief valves shall be of the size shown and shall be of a type that will release air and prevent the formation of a vacuum. The valves shall automatically release air when the lines are being filled with water and shall admit air into the line when water is being withdrawn in excess of the inflow. Valves shall be iron body with bronze or stainless steel trim and stainless steel float and BUNA-N Seats. The valve shall be APCO Model 144 Val-Matic Model 202C.2 or approved equal.

- B. Corporations shall be full opening with O-ring seal and bronze ball and conform to AWWA C800. Taps into ductile iron pipe may be made by direct tapping on the pipe or with a service saddle. Service saddles shall conform to AWWA C800, and be constructed of bronze or epoxy coated ductile iron. Saddles shall have a single or double strap.
- C. The outlet of the valve shall be equipped with a gooseneck and stainless steel screen as indicated on the drawings.
- D. Copper tubing shall be Type K, ASTM B88.
- E. Do not install vacuum and air relief valves until the system has been cleaned and tested.
- F. Insulation shall be ARMAFLEX insulation tape or approved equal. Insulation shall be closed cell, and built up to 14 layers to provide a minimum thickness of 1/2 inch. Insulation coating shall be per the manufacturer's recommendation.
- G. Heat tape shall be RAYCHEM Series XL-Trace. Tape shall be self regulating, provided with power kit, 8 watts per foot, 120 VAC. Install tape to provide 15 watts per foot.

2.9 CONCRETE:

- A. Concrete shall conform to the requirements of City of Albuquerque (COA) Standard Specification Section 101, 3,000-PSI, unless otherwise noted.

2.10 MECHANICAL COUPLINGS:

- A. Couplings shall comply with AWWA C219.
- B. Couplings shall be the sleeve type and shall provide a tight flexible joint under all reasonable conditions, such as pipe movements caused by expansion, contraction, slight settling or shifting in the ground, minor variations in trench gradients, and traffic vibrations. Couplings shall have a rated working pressure not less than the adjoining pipeline. The couplings shall consist of a steel middle ring, two steel followers, two gaskets, and the necessary steel bolts and nuts to compress the gaskets. The interior and exterior of the sleeve and followers shall be epoxy coated in accordance with AWWA C550. The dry coating thickness shall not be less than 12 mils. When installed within sections of pipeline to be restrained, the coupling shall be fully restrained for a minimum working pressure of 250 PSI, with a minimum safety factor of 2:1.

PART 3 EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS:

- A. Install the chilled water piping system in compliance with local governing regulations, and AWWAC600.
- B. Chilled water piping and valves shall be insulated in accordance with Section 02720.
- C. All crews shall be skilled and knowledgeable of the installation procedures for the work that they are performing. Should the Owner feel that this requirement is not being met, he may require the Contractor to arrange for a representative of the manufacturer to visit the site to confirm that proper installation procedures are being followed. The cost associated with the visit by the manufacturer's representative shall be borne solely by the Contractor.
- D. The Contractor shall hire a land surveyor, registered in the State of New Mexico, who shall establish the vertical and horizontal alignment of the lines. Refer to Section 02060 – GENERAL SITE REQUIREMENTS for additional survey requirements
- E. Do not make the connections to the existing system until such time that the system has been

cleaned and all hydrostatic testing has been completed. Do not install air relief valves until all hydrostatic testing has been completed.

3.2 USE OF PIPING SYSTEMS:

- A. Ductile iron pipe (pressure class pipe) and fittings shall be used for all underground chilled water site piping that is a minimum of 5-feet outside buildings and cooling towers.
- B. Ductile iron pipe (thickness class pipe) and fittings shall be used for all underground chilled water (CHW) and cooling tower connection (CTC) water piping under, and within 5-feet of buildings and cooling towers.

3.3 PIPE INSTALLATION:

- A. Ductile-Iron Pipe: Install in accordance with the recommended procedures set forth in AWWA C600 and City of Albuquerque Standard Specification Section 801, and as specified herein.
- B. The maximum allowable joint deflection will be as given in AWWA C600 and the pipe manufacturer, whichever is less. If the alignment required deflection in excess of the above limitations, special bends or a sufficient number of shorter lengths of pipe shall be utilized to provide angular deflections within the limits set forth.
- C. Cutting of pipe shall be done in a neat and workmanlike manner without damage to the pipe. Cutting shall be done with a mechanical wheel type cutter. Squeeze type mechanical cutters shall not be used. Prior to cutting, the Contractor shall measure the pipe circumference at the location of the cut to assure that the pipe diameter and circumference are within the tolerance specified by the manufacturer. After completing the field cut, the Contractor shall bevel the outside of the cut end per the manufacturer's recommendations.
- D. Pipe, fittings, and accessories shall be carefully lowered into the trench by means of derrick, ropes, belt slings, or similar equipment. Under no circumstances shall any of the piping materials be dropped or dumped into the trench. Care shall be taken to avoid abrasion of the pipe coating. Except as authorized by the Owner, pipe shall be laid with the bells facing in the direction of laying. The full length of each section of pipe shall rest solidly upon the bedding material, with recesses excavated to accommodate bells, joints, and fittings. Pipe that has the their joints disturbed after installation shall be taken up and re-laid. Pipe shall not be laid when trench conditions are unsuitable for the work. When work is not in progress, open ends of pipe, fittings, and valves shall be securely closed so that no water, soil, or debris can enter the pipes or fittings. Where any part of the coating or lining is damaged, the Contractor shall repair the damage to the satisfaction of the Owner. Pipe stub-outs for future connections shall be capped and fully restrained.
- E. Bedding and shading shall be in accordance with Section 02221 - EXCAVATION, TRENCHING, AND BACKFILLING FOR UTILITIES SYSTEMS.
- F. Backfilling shall be in accordance with Section 02221 - EXCAVATION, TRENCHING, AND BACKFILLING FOR UTILITIES SYSTEMS
- G. Install utility marking tape as indicated on the drawings and as specified in Section 02221 - EXCAVATION, TRENCHING, AND BACKFILLING FOR UTILITIES SYSTEMS The utility marking tape shall be labeled "CAUTION: CHILLED WATER LINES - DO NOT DRINK".

3.4 JOINT RESTRAINT:

- A. Install all joint restraint devices in accordance with the manufacturer's instructions and prior to pressure testing of the system.
- B. For all joint restraint devices with twist-off bolt heads, the twisted-off heads shall be placed

adjacent to the fitting to allow the inspector to observe them. The Owner shall only utilize thrust blocks with prior approval.

- C. If the system is pressure tested in sections, the Contractor shall install all necessary temporary joint restraint devices and/or blocking required to safely conduct tests.
- D. The use of concrete thrust blocks shall not be permitted, except where specifically detailed on the plans. Wrap pipe and insulate prior to placing concrete.

### 3.5 VALVES AND VALVE BOXES:

- A. Inspect the interior of the valve and clean. Operate valve to insure that there is no damage to the resilient seat. Install gate valves plumb and in accordance with the manufacturer's recommendations. Make pipe connections to the valve and block under valve with a 2500-PSI concrete and bricks supporting the valve and actuator. Prior to installing concrete, the valve and piping shall be insulated. Operate the valve to insure that it operates smoothly through the entire range of opening and closing.
- B. When the top of the operating nut is 4 feet or greater below finish grade, install a valve nut extension as detailed on the drawings.
- C. Set valve box riser plumb and centered over the operator nut. Do not allow the riser to bear directly onto the valve actuator. Clean all debris from within the riser. Set the frame and cover to finish grade. Install a concrete collar and identification plates as shown on the drawings.
- D. Install concrete collar around valve box as detailed on the drawings. Concrete shall be 3,000 PSI conforming to the City of Albuquerque (COA) Standard Specification for Public Works Construction, Section 101.

### 3.6 AIR RELIEF VALVES:

- A. Tap ductile iron pipe at the high point and install a corporation stop or service saddle and corporation stop. Install copper blow-off line at an upwards slope to the air relief valve. Install isolation stop in a location that it is accessible from within the vault
- B. After completion of hydrostatic testing of the mainline, set the air relief valve on a gravel base course and block. Valve shall be plumb and away from the vault walls to facilitate servicing the valve. Install gooseneck with a stainless steel screen on the outlet of the valve.
- C. Install heat tape and insulation per manufacturer's recommendations. Coat exterior of insulation.

### 3.7 AIR RELIEF VAULT:

- A. Construct concrete base per COA Standard Specification Section 920.
- B. Install manhole section, top slab, and the frame and cover per COA Standard Specification Section 920, grout opening around lid.

### 3.8 INTERIOR INSPECTION:

- A. Prior to installation inspect pipe and fitting to determine whether damage has occurred. If the inspection indicated damaged lining, debris, or other defects, correct such defects to satisfaction of Owner

### 3.9 CLEANING AND FLUSHING:

- A. It shall be the responsibility of the Contractor to keep the lines clean of all foreign materials

during construction.

- B. All lines shall be mopped or swabbed and a pig shall be pulled through the lines to remove debris, dust, and sand, and dirt.
- C. Should dirt, debris, and/or foreign material be allowed to accumulate in the lines, the Contractor shall be responsible to remove all such material from the line by flushing the lines or other approved methods. In the event that such measures are required, the Contractor shall provide a written proposal to the Owner stating the methods to be utilized. In review of the proposal, the Owner will consider the potential for adverse impacts on the Campus.

3.10 SEPARATION BETWEEN CHILLED WATER LINES AND POTABLE WATER LINES:

- A. The minimum separation between chilled water lines and potable water mains shall be 1.5 feet vertically and be 1.5 feet horizontally under all conditions. Where chilled water lines crosses above or less than be 1.5 feet below a water line, the chilled water line shall be constructed of mechanical joint ductile iron pipe, or concrete steel cylinder pipe, for a distance of ten (10) feet on either side of the water main crossing.
- B. The 1.5 feet horizontal and the 1.5 feet vertical dimension shall be measured from outside of pipe to outside of pipe.

3.11 HYDROSTATIC TESTING:

- A. Hydrostatic testing shall conform with AWWA C600 and as specified herein.
- B. Prior to conducting any hydrostatic testing, all final and temporary joint restraint devices shall be fully installed and all concrete cured sufficiently to obtain the design strength. The barrel of the pipe shall be sufficiently weighted to prevent movement of the pipe.
- C. The Contractor may conduct tests on segments of the system. All temporary thrust restraint and blocking shall be the responsibility of the Contractor.
- D. Pressure Test: After the pipe is laid, the joints completed, thrust restraint installed, taps made, and the trench partially backfilled leaving the joints exposed for examination, the newly laid piping or any section of piping, shall, unless otherwise specified, be subjected for 2 hours to a hydrostatic pressure test of 200-PSI (175-PSI minimum pressure at the highest elevation). The pressure shall not vary by more than  $\pm 5$ -PSIG for the duration of the test. Each valve shall be opened and closed several times during the test. Exposed pipe, joints, fittings, and valves shall be carefully examined during the partially open trench test. Joints showing visible leakage shall be replaced or remade as necessary. Cracked or defective pipe, joints, fittings, and valves, discovered in consequence of this pressure test, shall be removed and replaced with sound material, and the test shall be repeated until the test results are satisfactory.
- E. The requirement for the joints to remain exposed for the hydrostatic tests may be waived by the Engineer when one or more of the following conditions is encountered:
  - 1. Wet or unstable soil conditions in the trench.
  - 2. Compliance would require maintaining barricades and pedestrian and vehicular access around and across an open trench in a heavily used area that would require continuous surveillance to assure safe conditions.

The Contractor may request the waiver, setting forth in writing the reasons for the request and stating the alternative procedure proposed to comply with the required hydrostatic tests. Backfill placed prior to the tests shall be placed in accordance with the requirements of Section 02221 - EXCAVATION, TRENCHING, AND BACKFILLING FOR UTILITIES SYSTEMS. The line(s) shall be considered as having successfully passed the hydrostatic pressure test when there is



no leakage or seepage of any type at any joint.

- F. Leakage Test: The duration of each leakage test shall be at least 2 hours, and during the test the water line shall be subjected to 200 PSI pressure. Leakage is defined as the quantity of water to be supplied into the newly laid pipe, or any valved or approved section thereof, necessary to maintain the specified leakage test pressure after the pipe has been filled with water and the air expelled. No piping installation will be accepted until the leakage is less than the number of gallons per hour as determined by the formula:

$$L = 0.000100 ND P^{1/2}$$

In which L equals the allowable leakage in gallons per hour; N is the number of joints in the length of pipeline tested; D is the nominal diameter of the pipe in inches; and P is the average test pressure during the leakage test, in psi gauge. Should any test of pipe disclose leakage greater than that specified in the foregoing formula, the defective joints shall be located and repaired until the leakage is within the specified allowance, without additional cost to the Owner.

- G. Time for Making Test: Except for joint material setting or where concrete reaction backing necessitates a 5-day delay, pipelines jointed with rubber gaskets, mechanical or push-on joints, or couplings may be subjected to hydrostatic pressure, inspected, and tested for leakage at any time after partial completion of backfill.
- H. Concurrent Tests: The Contractor may elect to conduct the hydrostatic tests (pressure tests, and leakage test) concurrently. Regardless of the sequence of tests employed, the results of pressure tests, and leakage tests, shall be satisfactory as specified. All replacement, repair or re-testing required shall be accomplished by the Contractor at no additional cost to the Owner.

#### 3.12 FILLING LINES:

- A. The pipe shall be filled with potable water as recommended by the manufacturer before being subject to the hydrostatic tests. The Contractor shall arrange for the water source and the Contractor shall coordinate and pay all fees assessed by the water company.

#### 3.13 DRAINING LINES:

- A. In the event that any portion of the system is required to be drained, the Contractor shall notify the Owner of the time which such draining operations will occur and the method for disposal of the water. Should the Owner consider such operations to pose an adverse impact on the site, the Owner may require the Contractor to discharge the water into the sanitary sewer. The Contractor shall obtain all permits, and pay all fees required by the City of Albuquerque.

#### 3.14 CONNECTIONS TO THE EXISTING SYSTEM:

- A. Unless specifically approved by the Owner in writing, connections to the existing system, piping installed under other projects, and building piping, shall be made only after all pipes have been cleaned and all hydrostatic testing have been approved by the Owner.
- B. After the connection is made to the existing system, but prior to backfilling, the system shall be pressurized to 150 PSI, or pressure approved by the Owner. The pressure shall be maintained for 1 hour and the joints at the connection visually inspected for leaks.

#### 3.15 FINAL TURN-OVER OF THE PIPING:

- A. The system shall be turned-over to the Owner completely filled with water with all air removed. The quality of the water shall be of a quality acceptable to the Owner.

#### 3.16 COMPLETION CERTIFICATION:

- A. The Contractor shall provide a certification on the firm's letterhead and signed by a officer of the firm which states the following:
  - 1. The chilled water piping system has been installed and tested in conformance with the contract documents for the University of New Mexico Project No. 7-05630. All modifications to the design are clearly indicated on the attached as-built DRAWINGS.

END OF SECTION

SECTION02719

WATERSYSTEM

PART 1 GENERAL

1.1 RELATED DOCUMENTS:

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work of this section.

1.2 DESCRIPTION OF WORK:

- A. The extent of the new water services and modifications to the existing water system as indicated on the drawings and as specified herein. The water system includes, but is not limited to, the following:
  - 1. Water service pipe, fittings, and appurtenances.
  - 2. Gate valves and boxes.
  - 3. Joint restraint devices.
  - 4. System disinfecting, flushing, and testing.
  - 5. Modifications and connections to existing water systems.

1.3 LIMITATIONS:

- A. No connections shall be made to the existing piping until such time that the new piping has been tested, flushed, disinfected, and accepted for operation by the owner.
- B. All work associated with the modifications to the water system shall be conducted in an expedited manner to minimize the time frame during which the water supply is interrupted. All shutdowns of the existing system shall be scheduled in advanced with the owner.
- C. No water main shall be taken out of service unless all piping, fittings, and appurtenances required to construct the modifications to the lines are available on the project site.

1.4 QUALITY ASSURANCE

- A. Codes, standards, and standard details referenced herein.
- B. The Contractor shall conform to all rules and regulations of the New Mexico Environment Department, Drinking Water Bureau.

1.5 RELATED WORK SPECIFIED ELSEWHERE:

- A. Section 02060: GENERAL SITE REQUIREMENTS.
- B. Section 02221: EXCAVATION, TRENCHING AND BACKFILLING FOR UTILITIES SYSTEMS.
- C. City of Albuquerque (COA) Standard Specifications and Details for Public Works Construction (latest edition).
- D. Recommended Standards for Water Works, Five State standard (1997 Edition).

1.6 SAFETY:

- A. The Contractor shall adhere to all O.S.H.A. and other governing rules and regulations.
- B. Prior to pressurizing the system or any portion thereof, the contractor shall verify that all thrust restraint devices are installed, the piping has been center loaded, and the system adequately restrained to prevent movement of the pressurized system. All required temporary thrust restraints and taps to bleed air and fill the lines shall be installed by the Contractor as required.

1.7 SUBMITTALS:

- A. Product Data: Submit manufacturer's product data for each product specified for the potable water system.
- B. Certification from the valve manufacturer that all valves are bubble tight at a 200 PSI test pressure.
- C. Schedule for water system shutdowns.
- E. Disinfection reports.

PART 2 PRODUCTS

2.1 PRESSURE PIPE AND FITTINGS:

- A. General: Provide all piping, fittings, valves, appurtenances, and other required piping accessories required to complete the system. All pipe and fittings shall be compatible and rated for the specified hydrostatic test pressure.
- B. Ductile Iron Pipe (DIP):
  - 1. Ductile iron pipe shall be manufactured and tested in accordance with the AWWA C151. The pipe joints shall be push-on joint, mechanical joint, or integral restrained joint, meeting the requirements of AWWA C111. Ductile iron pipe 12-inches in diameter and less shall minimum pressure rating of not less than Pressure Class 350.
  - 2. Rubber gasket joints shall comply with AWWA C111.
  - 3. Bolts shall be high strength, low alloy steel bolts complying with AWWA C111.
  - 4. Flanged ductile iron pipe shall be manufactured in accordance with AWWA C115. Flanges shall be ductile iron, rated for 250 PSI working pressure, Bolt circle and bolt holes shall match those of ASME/ANSI B16.1, Class 125 and ASME/ANSI B16.5 Class 150 flanges. The minimum thickness class for ductile iron pipe to be threaded shall be Class 53.
  - 5. Ductile iron pipe shall have a standard thickness cement-mortar lining followed by a seal coat of asphaltic material in accordance with AWWA C104. The exterior surfaces of ductile iron pipe and fittings shall be coated with a bituminous material in accordance with AWWA C151 before shipment.
- C. Ductile Iron Fittings:
  - 1. Ductile iron fittings shall be manufactured and tested in accordance with the AWWA C110 or AWWA C153. The pipe joints shall be push-on joint, mechanical joint, or integral restrained joint, meeting the requirements of AWWA C111. Ductile iron fittings shall minimum pressure rating of not less than 350-PSI.

2. Fittings and specials shall be cement-mortar lined in accordance with AWWA C104. Linings shall be standard thickness and seal coated with a bituminous material. The exterior surfaces of all ductile iron fittings shall be coated with a bituminous material in accordance with AWWA C110.

2.2 POLYETHYLENE ENCASUREMENT:

- A. Polyethylene encasement shall conform to AWWA C105.

2.3 JOINT RESTRAINT DEVICES:

- A. All joints, fittings, and valves within the limits for joint restraint schedule shown on the drawings shall be fully restrained. The specific joint restraint devices shall be compatible with the type of piping material, style of joint, and type of fitting at the joint.
- B. Acceptable joint restraint devices include the following:
  1. Ductile iron mechanical style joints - EBAA Iron Sales, Inc. "Megalug" joint restraint system, Series 1100, approved equal.
  2. DIP push-on style joints – EBBA Iron Sales Series 1700 or approved equal.
  3. Integral joint restraint type - U.S. Pipe "TR Flex". Or Pacific States "Perma-Loc" restrained joint pipe and fittings, or approved equal. Joint restraint system shall be compatible with factory ends and field cut pipe ends.
- C. Mechanical joint restraint devices shall be rated for a minimum working pressure of 250 PSI, with a minimum safety factor of 2:1
- D. Field welding of ductile iron pipe for joint restraint shall not be permitted.
- E. Concrete thrust blocks shall conform to the City of Albuquerque Standard Specifications and Details for Public Works Construction.

2.4 MECHANICAL COUPLINGS:

- A. Couplings shall comply with AWWA C219.
- B. Couplings shall be the sleeve type and shall provide a tight flexible joint under all reasonable conditions, such as pipe movements caused by expansion, contraction, slight settling or shifting in the ground, minor variations in trench gradients, and traffic vibrations. Couplings shall have a rated working pressure not less than the adjoining pipeline. The couplings shall consist of a steel middle ring, two steel followers, two gaskets, and the necessary steel bolts and nuts to compress the gaskets. The interior and exterior of the sleeve and followers shall be epoxy coated in accordance with AWWA C550. The dry coating thickness shall not be less than 12 mils. When installed within sections of pipeline to be restrained, the coupling shall be fully restrained for a minimum working pressure of 250 PSI, with a minimum safety factor of 2:1.

2.5 GATE VALVES:

- A. Gate valves shall be resilient seated gate valves meeting the requirements of AWWA C509, and City of Albuquerque Standard Specification Section 801. The valves shall be certified bubble tight at 200 PSI. The exterior and interior shall be coated with a thermo-setting, or fusion bonded epoxy coating meeting the requirements of AWWA C550. The dry coating thickness shall not be less than 12 mils. Valves shall have mechanical style connections, except flanged joints may be used on the side of the valve that connects directly to a tee or tapping sleeve. Direct buried valves shall have a 2-inch operating nut. Valves shall open counter-clockwise.

- B. Except at locations where valves bolt to flanged tees, valves shall have mechanical joint ends.

2.6 VALVES BOXES:

- A. Valve box and cover shall consist of a cast iron box and cover and blue colored PVC riser as detailed on the drawings. The valve box and cover casting shall be manufactured in conformance with ASTM A48, Class 30B.
- B. Valve stem extensions shall comply with City of Albuquerque Standard Specification Section 801 and as detailed on the drawings.

2.7 CONCRETE:

- A. Concrete shall conform to the requirements of City of Albuquerque (COA) Standard Specification for Public Works Construction, Section 101, 2,500 PSI, unless otherwise noted.

2.8 TAPPING SLEEVES:

- A. All tapping sleeves shall conform to City of Albuquerque Standard Specification Section 130 working pressure rating 250 PSI.

2.9 SERVICE LINE MATERIALS:

- A. Service line materials shall conform to City of Albuquerque Standard Specification Section 802.

2.10 LOCATOR WIRE:

- A. Locator wire shall be 12 AWG solid copper, or stranded copper wire, PVC insulated, type UF, UL listed for direct burial in ground. Provide wire in 1,000 foot rolls.
- B. Splicing system shall consist of a copper wire crimp, PVC split case gland, and epoxy waterproof sealing compound. Connectors shall be 3M "Scotchlok", or approved equal.

PART 3 EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS:

- A. Install the potable water piping system in compliance with AWWA C600, local governing regulations, and City of Albuquerque Standard Specification Section 801.
- B. All crews shall be skilled and knowledgeable of the installation procedures for the work that they are performing. Should the Owner feel that this requirement is not being met, they may require the Contractor to arrange for a representative of the pipe manufacturer to visit the site to confirm that proper installation procedures are being followed. The cost associated with the visit by the manufacturer's representative shall be borne solely by the Contractor.
- C. The Contractor shall hire a land surveyor, who shall establish the vertical and horizontal alignment of the lines. Refer to Section 02060 – GENERAL SITE REQUIREMENTS for additional survey requirements
- D. Do not make the connections to the existing system until such time that the system has been cleaned, all hydrostatic testing has been completed, and disinfection of the system has been accepted by the Owner. Do not install air relief valves until all hydrostatic testing has been completed.

3.2 USE OF PIPING SYSTEMS:

- A. Ductile iron pipe and fittings shall be used in all potable water mains 4-inch and larger. Copper

service lines, 3-inch and smaller shall be used.

### 3.3 PIPE INSTALLATION:

- A. Ductile-Iron Pipe: Install in accordance with the recommended procedures set forth in AWWA C600 and City of Albuquerque Standard Specification Section 801, and as specified herein.
- B. All ductile iron pipe and fittings shall be polyethylene encased per AWWA C105.
- C. The maximum allowable joint deflection shall be the lesser of the joint deflection specified in AWWA C600 or the pipe manufacturer's data. If the alignment requires deflection in excess of the above limitations, special bends or a sufficient number of shorter lengths of pipe shall be utilized to provide angular deflections within the limits set forth.
- D. Cutting of pipe shall be done in a neat and workmanlike manner without damage to the pipe. Cutting shall be done with a mechanical wheel type cutter. Squeeze type mechanical cutters shall not be used. Prior to cutting, the Contractor shall measure the pipe circumference at the location of the cut to assure that the pipe diameter and circumference are within the tolerance specified by the manufacturer. After completing the field cut, the Contractor shall bevel the outside of the cut end per the manufacturer's recommendations.
- E. Pipe, fittings, and accessories shall be carefully lowered into the trench by means of derrick, ropes, belt slings, or similar equipment. Under no circumstances shall any of the piping materials be dropped or dumped into the trench. Care shall be taken to avoid abrasion of the pipe coating. Except as authorized by the Owner, pipe shall be laid with the bells facing in the direction of laying. The full length of each section of pipe shall rest solidly upon the bedding material, with recesses excavated to accommodate bells, joints, and fittings. Pipe that has the joints disturbed after installation shall be taken up and re-laid. Pipe shall not be laid when trench conditions are unsuitable for the work. When work is not in progress, open ends of pipe, fittings, and valves shall be securely closed so that no water, soil, or debris can enter the pipes or fittings. Where any part of the coating or lining is damaged, the Contractor shall repair the damage to the satisfaction of the Owner. Pipe stub-outs for future connections shall be capped and fully restrained.
- F. Bedding and shading shall be in accordance with Section 02221 - EXCAVATION, TRENCHING, AND BACKFILLING FOR UTILITIES SYSTEMS.
- G. Backfilling shall be in accordance with Section 02221 - EXCAVATION, TRENCHING, AND BACKFILLING FOR UTILITIES SYSTEMS.
- H. Install utility marking tape as indicated on the drawings and as specified in Section 02221 - EXCAVATION, TRENCHING, AND BACKFILLING FOR UTILITIES SYSTEMS. The utility marking tape shall be labeled "CAUTION: WATER LINES BELOW".

### 3.4 JOINT RESTRAINT:

- A. Install all joint restraint devices in accordance with the manufacturer's instructions and prior to pressure testing of the system. For all joint restraint devices with twist-off bolt heads, the twisted-off heads shall be placed adjacent to the fitting to allow the inspector to observe them. Thrust blocks shall only be utilized with prior approval by the Owner.
- B. If the system is pressure tested in sections, the Contractor shall install all necessary temporary joint restraint devices and/or blocking required to safely conduct the test.
- C. The use of concrete thrust blocks shall not be permitted, except where specifically noted on the plans, and as approved by the Owner.

### 3.5 VALVES AND BOXES:

- A. Inspect the interior of the valve and clean. Operate valve to insure that there is no damage to the resilient seat. Install gate valves plumb and in accordance with the manufacturer's recommendations. Make pipe connections to the valve and block under valve with a 2500-PSI concrete base support wrap pipe in polyethylene prior to placing concrete. Operate valve after installation to insure that it smoothly operates through the entire range of opening and closing.
- B. When the top of the operating nut is 4 feet or greater below finish grade, install a valve nut extension as detailed on the drawings.
- C. Set valve box riser plumb and centered over the operating nut. Do not allow the riser to bear directly onto the valve body. Clean all debris from within the riser. Set the frame and cover to finish grade. Install a concrete collar and identification plates as shown on the drawings.
- D. Install locator wire in valve box and coil 3 feet of wire under cover. Locate wire so it does not conflict with the operation of the valve.
- E. Install concrete collar around valve box as detailed on the drawings. Concrete shall be 3,000 PSI conforming to the City of Albuquerque (COA) Standard Specification for Public Works Construction, Section 101.

3.6 LOCATOR WIRE:

- A. Attach locator wire to the top of the all potable water line. Tape or lightly band wire to the pipe to prevent displacement of the wire during shading operations. Do not tighten bands in any manner that would damage the wire or the pipe.
- B. At valves, run a lead from the locator wire up to the top of the valve box and coil three (3) feet of wire in the box as indicated on the drawings.
- C. The contractor shall minimize the number of splices in the wire. All splices shall be made with a watertight gland.

3.7 INTERIOR INSPECTION:

- A. Inspect pipe and fittings prior to installation to determine whether has occurred. If the inspection indicated debris, damaged lining, or other defects, correct such defects to satisfaction of Owner

3.8 CLEANING AND FLUSHING:

- A. It shall be the responsibility of the Contractor to keep the lines clean of all foreign materials during construction.
- B. Should dirt, debris, and/or foreign material be allowed to accumulate in the lines, the Contractor shall be responsible to remove all such material from the line by flushing the lines or other approved methods. In the event that such measures are required, the Contractor shall provide a written proposal to the Owner stating the methods to be utilized. In review of the proposal, the Owner will consider the potential for adverse impacts on the Campus.
- C. Flush all potable water lines at 2.5 FPS in accordance with the rules and regulations of the New Mexico Environment Department, Drinking Water Bureau. The Contractor shall provide the water source for the flushing of the system and safely dispose of all water in accordance with all governing regulations.

3.9 SEPARATION BETWEEN CHILLED WATER LINES AND POTABLE WATER LINES:

- A. The minimum separation between potable water lines and chilled water mains shall be 1.5 feet vertically and 1.5 feet horizontally under all conditions. Where chilled water lines cross above or



less than 1.5 feet below a water line, the water line shall be constructed of mechanical joint ductile iron pipe for a distance of ten (10) feet on either side of the water main crossing.

- B. The 1.5 foot horizontal and the 1.5 feet vertical dimension shall be measured from outside of pipe to outside of pipe.

3.10 HYDROSTATIC TESTING (PIPE 4-INCH AND LARGER)

- A. Hydrostatic testing shall conform with AWWA C600 and as specified herein.
- B. Prior to conducting any hydrostatic testing, all final and temporary joint restraint devices shall be fully installed and all concrete cured sufficiently to obtain the design strength. The barrel of the pipe shall be sufficiently weighted to prevent movement of the pipe.
- C. The Contractor may conduct tests on segments of the system. All temporary thrust restraint and blocking shall be the responsibility of the Contractor.
- D. Pressure Test: After the pipe is laid, the joints completed, thrust restraint installed, taps made, and the trench partially backfilled leaving the joints exposed for examination, the newly laid piping or any section of piping, shall, unless otherwise specified, be subjected for 2 hours to a hydrostatic pressure test of 200-PSI (185-PSI minimum pressure at the highest elevation). The pressure shall not vary by more than  $\pm 5$ -PSIG for the duration of the test. Each valve shall be opened and closed several times during the test. Exposed pipe, joints, fittings, and valves shall be carefully examined during the partially open trench test. Joints showing visible leakage shall be replaced or remade as necessary. Cracked or defective pipe, joints, fittings, and valves, discovered in consequence of this pressure test, shall be removed and replaced with sound material, and the test shall be repeated until the test results are satisfactory.
- E. The requirement for the joints to remain exposed for the hydrostatic tests may be waived by the Engineer when one or more of the following conditions is encountered:
  - 1. Wet or unstable soil conditions in the trench.
  - 2. Compliance would require maintaining barricades and pedestrian and vehicular access around and across an open trench in a heavily used area that would require continuous surveillance to assure safe conditions.

The Contractor may request the waiver, setting forth in writing the reasons for the request and stating the alternative procedure proposed to comply with the required hydrostatic tests. Backfill placed prior to the tests shall be placed in accordance with the requirements of Section 02221 - EXCAVATION, TRENCHING, AND BACKFILLING FOR UTILITIES SYSTEMS. The line(s) shall be considered as having successfully passed the hydrostatic pressure test when there is no leakage or seepage of any type at any joint.

- F. Leakage Test: The duration of each leakage test shall be at least 2 hours, and during the test the water line shall be subjected to 200 PSI pressure. Leakage is defined as the quantity of water to be supplied into the newly laid pipe, or any valved or approved section thereof, necessary to maintain the specified leakage test pressure after the pipe has been filled with water and the air expelled. No piping installation will be accepted until the leakage is less than the number of gallons per hour as determined by the formula:

$$L = 0.000130ND P^{1/2}$$

In which L equals the allowable leakage in gallons per hour; N is the number of joints in the length of pipeline tested; D is the nominal diameter of the pipe in inches; and P is the average test pressure during the leakage test, in psi gauge. Should any test of pipe disclose leakage greater than that specified in the foregoing formula, the defective joints shall be located and repaired until the leakage is within the specified allowance, without additional cost to the Owner.

- G. Time for Making Test: Except for joint material setting or where concrete reaction backing necessitates a 5-day delay, pipelines jointed with rubber gaskets, mechanical or push-on joints, or couplings may be subjected to hydrostatic pressure, inspected, and tested for leakage at any time after partial completion of backfill.
  - H. Concurrent Tests: The Contractor may elect to conduct the hydrostatic tests (pressure tests, and leakage test) concurrently. Regardless of the sequence of tests employed, the results of pressure tests, and leakage tests, shall be satisfactory as specified. All replacement, repair or re-testing required shall be accomplished by the Contractor at no additional cost to the Owner.
- 3.11 FILLING LINES:
- A. The pipe shall be filled with potable water as recommended by the manufacturer before being subject to the hydrostatic tests. The Contractor shall arrange for the water source and the Contractor shall coordinate and pay all fees assessed by the water company.
- 3.12 DRAINING LINES:
- A. In the event that any portion of the system is required to be drained, the Contractor shall notify the Owner of the time which such draining operations will occur and the method for disposal of the water. Should the Owner consider such operations to pose an adverse impact on the site, the Owner may require the Contractor to discharge the water into the sanitary sewer. The Contractor shall obtain all permits, and pay all fees required by the City of Albuquerque.
- 3.13 CONNECTIONS TO THE EXISTING SYSTEM:
- A. Unless specifically approved by the Owner in writing, connections to the existing system shall be made only after all pipes have been flushed, and the hydrostatic testing and disinfection have been accepted by the Owner.
  - B. After the connection is made to the existing system, but prior to backfilling, the system shall be pressurized to 150 PSI, or pressure approved by the Owner. The pressure shall be maintained for 1 hour and the joints at the connection visually inspected for leaks.
- 3.16 FINAL TURN-OVER OF THE PIPING:
- A. The system shall be turned-over to the Owner completely filled with water with all air removed. The quality of the water shall be of a quality acceptable to the Owner.
- 3.17 SALVAGED MATERIAL:
- A. All existing piping and appurtenances removed shall become the property of the Contractor unless specifically noted otherwise on the drawings..
- 3.18 DISINFECTION AND FLUSHING:
- A. After completion of hydrostatic testing, flush and disinfect all water lines per State of New Mexico, Department of the Environment, Drinking Water Bureau Rules and Regulations. Submit copies of all test results to the Owner. It shall be the sole responsibility of the Contractor to arrange for and pay all bacteriological testing. The potable water line will not be put into service until test results indicate an "absent" reading for bacteriological contamination.
- 3.19 VALVE BOX ADJUSTMENT:
- A. Adjust all water valve boxes (new and existing) within the construction area to finish grade.

END OF SECTION

SECTION02720

UNDERGROUND CHILLED WATER PIPING INSULATION

PART 1 GENERAL

1.1 RELATED DOCUMENTS:

- A. Drawings and general provision of the Contract, including General and Supplementary Conditions and Division 1 Specification sections apply to work of this Section.

1.2 DESCRIPTION OF WORK:

- A. Insulation of underground chilled water system, including piping, fittings, valves, and appurtenances.

1.3 LIMITATIONS:

- A. Materials specified shall be stored, transported, and applied in accordance with the manufacturer's published recommendations, and all governing regulations.
- B. The insulation shall be applied only when the weather, and temperature, is within the limitations published by the manufacturer of the product. When the ambient temperature is below the limitations published by the manufacturer, the Contractor may provide supplemental heating and enclosures as required and as approved by the Owner.

1.4 QUALITY ASSURANCE:

- A. The insulation Contractor shall have a minimum of three (3) years experience with applications similar to the work included in this project.
- B. All methods of application of the insulating materials, that are not specified herein, shall be prior approved by the Owner.

1.5 IDENTIFICATION:

- A. Each package or standard container of material delivered to the site shall have the manufacturer's stamp, or label, attached to the container. The labeling shall state the manufacturer's name, product identification, and a description of material.

1.6 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 02060 GENERAL SITE REQUIREMENTS
- B. Section 02221: EXCAVATION, TRENCHING & BACKFILLING FOR UTILITIES SYSTEMS
- C. Section 02718: DIRECT BURIED CHILLED WATER SYSTEM AND COOLING TOWER CONNECTION PIPING
- D. Section 15250: MECHANICAL SYSTEMS INSULATION

1.7 SAFETY:

- A. The Contractor shall adhere to all O.S.H.A. requirements.

- B. All insulation shall be applied in strict conformance with the manufacturer's published instructions. The Contractor shall maintain copies of the Material Safety Data Sheets (MSDS) on the site, for each product used.
- C. The method of application and protective equipment shall ensure that the general public, other Contractors and property do not come in contact with uncured insulation. The Contractor shall be solely responsible for all claims and all cleanup resulting from over-spray and damage/injury to personnel and property.

1.8 SUBMITTALS:

- A. Product Data: Submit manufacturer's product data, application instructions MSDS, for each product to be used.
- B. Application Procedures: Submit a written description of the application techniques to be used, and a description of the measures to be enacted to protect physical features and personnel within the area.
- C. Documentation of Experience: Submit certification of the applicator's past experience. The Certification shall be on the Company letterhead, signed by an officer of the firm, and provide a description, contact reference, with contact telephone number, and similar project complete by the applicator.

PART 2 PRODUCTS

2.1 RIGID BLOWN FOAM INSULATION:

- A. The insulation shall be a non-CFC blown polyurethane rigid foam. The insulation shall have high insulation efficiency, high strength to weight ratio, and non-porous surface. The insulation shall be suitable for bonding to the piping material.
- B. The insulation shall have a maximum thermal conductivity resistance, when measured in accordance with ASTM C-518, of:

Initial - 6.2 R per inch thickness  
Aged - 5.6 R per inch thickness

- C. The insulation have a maximum dimensional stability of 2 percent when measure at one week and four weeks in accordance with ASTM D-2126.
- D. The insulation shall have the following physical properties:
 

Density:	2.5 - 2.7 lb/ft. <sup>2</sup> (ASTM D-1622)
Compressive strength:	40 (± 5%) PSI (ASTM D-1621)
Tensile strength:	60 PSI (ASTM D-1623)
Percent closed cell:	92 min (ASTM D-2856)
Moisture permeation rate:	1.4 perm/in (ASTM C-355)
- E. Polyurethane using CFC's or water, as the principal blowing agent shall not be acceptable.
- F. Insulation products used for the repair of damaged insulation shall be fully compatible with the installed insulation any provide the physical properties specified above.
- G. Acceptable products include Texthane 241 series manufactured by Flexible Products Company, a Division of Dow Chemical, and approved equal.

PART 3 EXECUTION

3.1 GENERAL:

- A. Prior to applying the insulation, the surface of the chilled water piping, fittings and appurtenances shall be cleaned of soil, grease, oils, and all foreign material that would prevent adhesion of the insulation to the piping system.
- B. Valves, corporation stops, bolts, joint restraint devices, and other mechanical style joints shall be tightly wrapped in polyethylene sheeting to provide a bond break between the insulation and mechanical devices. The extent of the polyethylene sheeting shall be limited to the extent required to expose the mechanical device in the event that future maintenance operations required access to them.
- C. The insulation shall be applied in strict accordance with the manufacturer's published instructions and recommendations.

3.2 APPLICATION:

- A. The following application methods are acceptable for use on the project. All other methods shall be prior approved by the Owner.
- B. Method A: (All pipe diameters)

Apply rigid blown foam insulation to the exterior of the piping, or to a portion of the piping, prior to the installation of the piping. Seal ends of pipe, fittings, and appurtenances to prevent insulation from entering the interior of the pipe. The thickness of the insulation shall not be less than specified. The application of the insulation may be carried out adjacent to the trench or at a remote site that is acceptable to the Owner. Upon installation on the piping, apply the insulation to all portions of the piping that were not previously insulated, and where the insulation has been damaged. The interface between the various applications of insulation shall be fully bonded together.

- C. The Contractor shall repair all portions of the insulation that are damaged or defective to the satisfaction of the Owner. Damaged insulation that restricts the proper repair of the specific area shall be removed prior to the re-application of the insulation.
- D. Voids under the haunches of the pipe shall not be acceptable.
- E. Avoid excess buildup of insulation within the trench that could create future settlement of the trench and backfill. If excess buildup of insulation material should occur, the Contractor shall remove excess material prior to placement of the shading material around the pipe.

3.3 MINIMUM INSULATION THICKNESS:

- A. THE MINIMUM THICKNESS OF THE CURED INSULATION SHALL BE ONE (1) INCH.
- B. The Owner reserves the right to cutout sample sections of the installed insulation to verify the thickness of the insulation and cell structure. The Contractor shall repair all areas where sample have been removed.

3.4 BEDDING AND SHADING AROUND INSULATED PIPING:

- A. Care shall be given during bedding and shading operations and compaction operations to avoid damaging the insulation. Only clean bedding and shading material shall be placed adjacent to the insulation. Mechanical compaction equipment shall be kept a minimum of 3-inches away from the insulation. Do not place bedding and shading material around the piping until such time that the insulation has cured.
- B. Should damage occur to the insulation during shading and backfilling operations, the Contractor shall immediately stop all related shading and backfilling operations. The insulation shall be

repaired to the satisfaction of the Owner prior to recommencing the shading and backfilling operations.

3.5 CLEAN-UP:

- A. Spilled material, empty containers and unused contents shall be disposed of, by the Contractor, off-site, in accordance with all local, state, and federal regulations.
- B. Clean all insulation materials from all surfaces which will be exposed after backfilling operations. The Contractor shall repair all finished surfaces damaged to the satisfaction of the Owner.

3.6 PROTECTION OF PERSONNEL AND ADJACENT PROPERTY:

- A. The Contractor shall comply with all OSHA and existing environmental rules and regulations.
- B. The Contractor shall install and maintain all required shields, barricades, and other protective devices, to prevent over-spray from coming in contact with adjacent property or personnel. Any and all claims for damage and nuisance to persons or property shall be borne solely by the Contractor.

END OF SECTION

SECTION 02827

SWING GATES

PART 1 GENERAL

1.01 SECTION INCLUDES:

- A. Swing gate operator
- B. Gate hardware
- C. Swing gate controls

1.02 RELATED WORK:

- A. Division 05500 MISCELLANEOUS METALS
- B. Division 16000-Electrical

1.3 SUBMITTALS:

- A. General: Submit the following according to the Conditions of the Contract and Division 1 Specifications Sections.
- B. Product Data for operator.
  - 1. Shop Drawings showing fabrication and erection of gate, gate operator and gate operator controls.

1.4 QUALITY ASSURANCE:

- A. Gate operator manufacturer Qualifications: Firm experience in producing gate operators similar to those indicated for this Project, with a record of successful in-service performance, and sufficient production capacity to produce gate operator units required without causing delay in the Work.
- B. Single-Source Responsibility: For each gate and gate operator type required, obtain gate operator from one source of a single manufacturer.

1.5 REGULATORY REQUIREMENTS:

- A. Gate operator shall be constructed so as to meet the "Minimum Performance Criteria" for Class I, II, III, and IV Gate operators, as specified in UL325 and UL-991.

1.6 PROJECT CONDITIONS:

- A. Field Measurements: Take field measurements prior to preparation of shop drawings and fabrication to ensure proper fitting. Show recorded measurements on final shop drawings. Coordinate fabrication schedule with construction progress to avoid delay.



PART 2 PRODUCTS

2.1 MANUFACTURERS:

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated in the Work include, but are not limited to the following:

1. Manufacturers include:
  - a. Elite Access Systems Inc.
  - b. Edko, Inc.
  - c. Or prior approved equal

2.2 MATERIALS:

A. Swing Gate Operator: Elite CSW-200-UL-1HP Swing Gate Operator as manufactured by Elite Access Systems Inc. or prior approved equal.

1. Gate operator shall be heavy a duty, a 250 lbs. pulling torque capacity, industrial duty, motor with soft start.
2. Solid state controller shall have a Monitored Photo-Eye circuit, Self Adjusting / Monitored Current Sensing, Timer to Close, Maximum Run Timer and Self Diagnostics. Operator shall have a detachable oversized field terminal strip and a separate accessory 24v power supply and switchable left hand / right hand conversion and Master/Slave operation for precise synchronized movement & communication between two gate operators.
3. Operator shall have reversing sensor that monitors motor current . The gate shall automatically reverse upon contact of an obstruction ie. vehicle.
4. Operator shall be completely prewired and factory tested.
5. Provide Battery Backup. All units shall have a lockable access panel for manual disconnect.
6. Operator arms to be a non-scissor action arm.

B. Swing Gates:

1. Construct Swing Gate as detailed in drawings. Refer section 05500 Miscellaneous Metals for assembly guidelines.

C. Swing Gate Controls: EKP-485 keypad or prior approved equal.

1. Provide heavy duty, powercoat box, numerical programmable keypad entry with key override, one at entry and one exit for each motorized gate, as shown on drawings.
2. Keypad to have visual LED status, audible feedback, and lighted stainless steel keys.

D. Gate Hinges:

1. 5 ft leaf (10 ft. gate opening): Install the "HDP 300" as manufactured by Elite Access Systems, Inc.

2. 10 ft. leaf (20 ft. gate opening): Install "Power Hinge" as manufactured by Elite Access Systems, Inc. Weld to tubesteel frame members as detailed.
3. Personnel man-gates (3'-0" x 7'-0" and 4'-0" x 8'-0"): Install the "HDP 100" as manufactured by Elite Access.

2.3 FINISHES:

- A. Colors: Gate to have powercoat finish, color to be selected by architect.

PART 3 EXECUTION

3.1 INSTALLATION:

- A. General: Coordinate location of operator with architect prior to installation.
- B. Contractor to coordinate install of all materials including but not limited to the foundation required to support the gate operator.

END OF SECTION

SECTION02990

PRECAST STEAM TUNNEL

PART 1 GENERAL

1.1 RELATED DOCUMENTS:

- A. Drawings and general provision of the Contract, including General and Supplementary Conditions and Division 1 Specification sections apply to work of this Section.

1.2 DESCRIPTION OF WORK:

- A. Construction and installation of precast concrete steam tunnel system vault and appurtenances.

1.3 REFERENCES:

- A. American Association of State Highway and Transportation Officials (AASHTO).
  - 1. Standard Specification for Highway Bridges.
- B. ACI 304 – Guide for Measuring, Mixing, Transporting and Placing Concrete.
- C. ACI 318 - Building Code Requirements for Reinforced Concrete.
- D. ASTM C-75 – Reinforced Concrete Culverts, Storm Drains, and Sewer Pipe.
- E. ASTM C478 - Specification for Precast Reinforced Concrete Manholes Sections.
- F. ASTM C857 - Standard Practice for Minimum Structural Design Loading for Underground Precast Concrete Utility Structures.
- G. ASTM C858 - Standard Specification for Underground Precast Concrete Utility Structures.
- H. ASTM C890 - Standard Practice for Minimum Structural Design Loading for Monolithic or Sectional Precast Concrete Water and Wastewater Structures.
- I. ASTM C913 - Standard Specification for Precast Concrete Water and Wastewater Structures.
- J. ASTM C990 - Standard Specification for Joints for Concrete Pipe, Manholes and Precast Box Sections Using Preformed Flexible Joint Sealants.
- K. AWS D1.4 - Structural Welding Code - Reinforcing Steel.
- L. CRSI Manual of Standard Practice.

1.4 QUALITY ASSURANCE:

- A. Precast concrete producer shall demonstrate adherence to the standards set forth in the National Precast Concrete Association Quality Control Manual. Precast concrete producer shall meet requirements written in subparagraph 1 or 2.
  - 1. NPCA Certification - The precast concrete producer shall be certified by the National Precast Concrete Association's Plant Certification Program prior to and during production of the products for this project.

2. Qualifications, Testing and Inspection:

- a. The Precast concrete producer shall have been in the business of producing precast concrete products similar to those specified for a minimum of 5 years. The precast concrete producer shall maintain a permanent quality control department or retain an independent testing agency on a continuing basis. The agency shall issue a report, certified by a licensed engineer, detailing the ability of the precast concrete producer to produce quality products consistent with industry standards.
- b. The Precast concrete producer shall show that the following tests are performed in accordance with the ASTM standards indicated. Tests shall be performed for each 150 cu. yd. of concrete placed, but not less frequently than once per week.
  - 1) Slump: C143
  - 2) Compressive Strength: C31, C192, C39
  - 3) Air Content (when air-entrained concrete is being used): C231 or C173
  - 4) Unit Weight: C138
- c. The Precast concrete producer shall provide documentation demonstrating compliance with this paragraph.
- d. The Owner may place an inspector in the plant when the products covered by this specification are being manufactured.

1.5 DELIVERY, STORAGE AND HANDLING:

- A. Handling: Products shall be stored, handled shipped and unloaded in a manner to minimize damage. Lifting holes or inserts shall be consistent with industry standards. Lifting shall be accomplished with methods or devices intended for this purpose.
- B. Acceptance at Site: The Owner's representative shall make final inspection and acceptance of the precast concrete products upon arrival at the jobsite.

1.6 IDENTIFICATION:

- A. Each precast unit delivered to the site shall have the manufacturer's stamp, or label, attached to the unit. The labeling shall state the manufacturer's name, and product identification.

1.7 RELATED WORK SPECIFIED ELSEWHERE:

- A. Section 02060 GENERAL SITE REQUIREMENTS
- B. Section 02221: EXCAVATION, TRENCHING & BACKFILLING FOR UTILITIES SYSTEMS
- C. Division 3: CAST-IN-PLACE CONCRETE
- D. Section 07160: BITUMINOUS DAMP-PROOFING (WATERPROOFING)
- E. Division 15: MECHANICAL SYSTEMS

1.8 SAFETY:

- A. The Contractor shall adhere to all O.S.H.A. requirements, including working within confined spaces.

1.9 SUBMITTALS:

A. ProductData:

1. For standard precast concrete units, the precast concrete producer shall supply cut sheets showing conformance to project drawings and requirements and to applicable ASTM specifications listed in this specification. The Precast concrete producer shall certify that such products will meet the ASTM specifications.
2. For proprietary precast concrete units, the precast concrete producer may supply standard plans or informative literature. Supporting calculations and design details shall be available upon request. The Precast concrete producer shall warrant that such products will perform the intended task.

B. ShopDrawings:

1. Plans for custom-made precast concrete units shall be shop drawings furnished by the precast concrete producer for approval by the Owner. These drawings shall show complete design, installation, and construction information in such detail as to enable the Owner to determine the adequacy of the proposed units for the intended purpose. Details of steel reinforcement size and placement as well as supporting design calculations, if appropriate, shall be included. The drawings shall include a schedule, which will list the size and type of precast concrete units at each location where they are to be used. The precast concrete units shall be produced in accordance with the approved drawings.

- C. Access Doors and Ladders: Submit manufacturer's literature detailing each unit and finishes.

PART 2 PRODUCTS

2.1 GENERAL:

- A. The precast steam tunnel, cover, and risers shall be of the size indicated on the drawings.
- B. The precast steam tunnel assembly shall be rated for AASHTO HS-20 wheel loading, with the wheel load applied directly on the covet of the tunnel.
- C. Provide all embeds, anchors, and accessories indicated on the drawings, and required to install the utility lines within the tunnel.

2.2 MANUFACTURERS:

- A. The precast concrete manufacturer must meet the guidelines written in paragraph 1.04.

2.3 MANUFACTURED PRECAST UNITS:

- A. Precast Concrete: Provide all units shown in Contract Documents and as needed for a complete and proper installation
- B. Design Criteria - Design units in accordance with:
  1. ACI 304 and 318.

2. CRSI Manual of Standard Practice.

3. Applicable ASTM Standard(s).

C. Finishes

1. Formed non-architectural surfaces: Surfaces cast against approved forms using industry practice in cleaning forms, designing concrete mixes, placing and curing concrete. Normal color variations, form joint marks, small surface holes caused by air bubbles, and minor chips and spalls will be tolerated but no major imperfections, honeycombs or other defects will be permitted.

2. Unformed surfaces: Surfaces finished with a vibrating screed, or by hand with a float. Normal color variations, minor indentations, minor chips and spalls will be tolerated but no major imperfections, honeycombs, or other defects shall be permitted.

3. Damp-proofing per Section 07160.

D. Patching and Repairs

1. No repair is required to formed surfaces that are relatively free of air voids and honeycombed areas.

2. Repairing Minor Defects - Defects that will not impair the functional use or expected life of a manufactured precast concrete product may be repaired by any method that does not impair the product.

3. Repairing Honeycombed Areas - When honeycombed areas are to be repaired, all loose material shall be removed and the areas cut back into essentially horizontal or vertical planes to a depth at which coarse aggregate particles break under chipping rather than being dislodged. Proprietary repair materials shall be used in accordance with the manufacturer's instructions. If a proprietary repair material is not used, the area shall be saturated with water and, immediately prior to repair, the area should be damp, but free of excess water. A cement-sand grout or an approved bonding agent shall be applied to the chipped surfaces, followed immediately by consolidating an appropriate repair material into the cavity.

4. Repairing Major Defects - Defects in precast concrete products which impair the functional use or the expected life of products shall be evaluated by qualified personnel to determine if repairs are feasible and, if so, to establish the repair procedure.

2.4 CONCRETE MATERIALS:

A. Concrete: Concrete shall be a uniform mix of quality materials listed in Article 2.4. Mix proportions shall be determined by following the standards in ACI 318 Chapter 5. Recommendations for selecting proportions for concrete are given in detail in Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete (ACI 211.1). Recommendations for lightweight concrete are given in Standard Practice for Selecting proportions for Structural Lightweight Concrete (ACI 211.2).

1. Water-Cement Ratio: Concrete that will be exposed to freezing and thawing shall contain entrained air and shall have water-cement ratios of 0.45 or less. Concrete which will not be exposed to freezing, but which is required to be watertight, shall have a water-cement ratio of 0.48 or less if the concrete is exposed to fresh water, or 0.45 or less if exposed to brackish water or sea water. For corrosion protection, reinforced concrete exposed to deicer salts, brackish water or seawater shall have a water-cement ratio of 0.40 or less.

2. Air Content: The air content of concrete that will be exposed to freezing conditions shall be within the limits given in Table 1.

Table 1

Nominal Maximum Aggregate Size (Inches)	Air Content, %
3/8	4.5 to 7.5
1/2	4.0 to 7.0
3/4	3.5 to 6.5
1	3.0 to 6.0
1-1/2	3.0 to 6.0

3. Compressive Strength: All concrete shall develop a minimum compressive strength of 7,000 psi in 28 days unless other strengths are designated on the drawings.

B. Portland Cement: ASTM C150, V.

C. Aggregates: ASTM C33 or C330.

D. Water: Potable or free of deleterious substances in amounts harmful to concrete or embedded metals.

E. Admixtures:

1. Air-entraining: ASTM C260
2. Water reducing, retarding, accelerating, high range water reducing: ASTM C494
3. Pozzolans, fly ash and other mineral admixtures: ASTM C618
4. Ground granulated blast furnace slag: ASTM C989

## 2.5 REINFORCEMENT AND CONNECTION MATERIALS:

A. Provide all reinforcement, accessory and connection materials required. Concrete reinforcement shall be steel bars or welded wire fabric, or a combination thereof.

B. Reinforcing Bars:

1. Deformed Billet-steel: ASTM A615.
2. Deformed Rail-steel: ASTM A616.
3. Deformed Axle-steel: ASTM A617.
4. Deformed Low-alloy steel: ASTM A706.

C. Reinforcing Wire:

1. Plain Wire: ASTM A82.
2. Deformed Wire: ASTM A496.

D. Welded Wire Fabric:

1. Plain Wire: ASTM A185.
  2. Deformed Wire: ASTM A497.
- E. Inserts and Embedded Metal - All items embedded in concrete shall be of the type required for the intended task, and meet the following standards:
1. Structural steel plates, angles, etc: ASTM A36
  2. Welded studs: AWS D1.1
  3. Finishes: Hot-dipped galvanized: ASTM A152 or Zinc-rich coating: MIL-P-2135 self-curing, one component, sacrificial
- F. Joint Sealant and Joint Gaskets:
1. External Sealing Bands for Noncircular Sewer, Storm Drain, and Culvert Pipe: ASTM C877.
  2. Joints for Concrete Pipe, Manholes, and Manufactured Box Sections Using Preformed Flexible Joint Sealants: ASTM C990
- G. Grout:
1. Cement grout: Portland cement with enough water for the required strength and sand for proper consistency. May contain mineral or chemical admixtures, if approved by Owner's representative.
  2. Non-shrink grout: Premixed, packaged expansive and non-expansive shrink-resistant grout.

## 2.6 FABRICATION:

- A. Forms for manufacturing precast concrete products shall be of the type and design consistent with industry standards. They should be capable of consistently providing uniform products and dimensions. Forms shall be constructed so that the forces and vibrations to which the forms will be subjected can cause no product damage. Forms shall be cleaned of concrete build-up after each use. Form release agents shall not be allowed to build up on the form casting surfaces.
- B. Reinforcement: Cages of reinforcement shall be fabricated either by tying the bars, wires or welded wire fabric into rigid assemblies or by welding where permissible in accordance with AWS D1.4. Reinforcing shall be positioned as specified by the design and so that the concrete cover conforms to requirements. The tolerance on concrete cover shall be one-third of that specified but not more than 1/2 in. Concrete cover shall not be less than 1/2 in. Positive means shall be taken to assure that the reinforcement does not move significantly during the casting operations.
- C. Embedded Items: Embedded items shall be positioned at locations specified in the design documents. Inserts, plates, weldments, lifting devices and other items to be imbedded in precast concrete products shall be held rigidly in place so that they do not move significantly during casting operations.
- D. Placing Concrete:
1. Concrete shall be deposited into forms as near to its final location as practical. The free



fall of the concrete shall be kept to a minimum. Concrete shall be consolidated in such a manner that segregation of the concrete is minimized and honeycombed areas are kept to a minimum. Vibrators used to consolidate concrete shall have frequencies and amplitudes sufficient to produce well consolidated concrete.

2. Cold Weather Requirements: Recommendations for cold weather concreting are given in detail in Cold Weather Concreting reported by ACI Committee 306.
  - a. Adequate equipment shall be provided for heating concrete materials and protecting concrete during freezing or near-freezing weather.
  - b. All concrete materials and all reinforcement, forms, fillers, and ground with which concrete is to come in contact shall be free from frost.
  - c. Frozen materials or materials containing ice shall not be used.
  - d. In cold weather the temperature of concrete at the time of placing shall not be below 45° F. Concrete that freezes before its compressive strength reaches 500 psi shall be discarded.
3. Hot Weather Requirements - Recommendations for hot weather concreting are given in detail in Hot Weather Concreting reported by ACI Committee 305.
  - a. During hot weather, proper attention shall be given to ingredients, production methods, handling, placing, protection, and curing to prevent excessive concrete temperatures or water evaporation that could impair required strength or serviceability of the member or structure. The temperature of concrete at the time of placing shall not exceed 90° F.

E. Curing:

1. Curing by Moisture Retention - Moisture shall be prevented from evaporating from exposed surfaces until adequate strength for stripping is reached by one of the following methods:
  - a. Cover with polyethylene sheets a minimum of 6 mils thick.
  - b. Cover with burlap or other absorptive material and keep continually moist.
  - c. Use of a membrane-curing compound applied at a rate not to exceed 200 sq. ft. per gallon, or per manufacturers' recommendations.
2. Surfaces that will be exposed to weather during service shall be cured as above a minimum of 3 days. Forms shall be considered effective in preventing evaporation from the contact surfaces. If air temperature is below 50°F the curing period shall be extended.
3. Curing with Heat and Moisture: Concrete shall not be subjected to steam or hot air until after the concrete has attained its initial set. Steam, if used, shall be applied within a suitable enclosure, which permits free circulation of the steam. If hot air is used for curing, precautions shall be taken to prevent moisture loss from the concrete. The temperature of the concrete shall not be permitted to exceed 160° F. These requirements do not apply to products cured with steam under pressure in an autoclave.

- F. Stripping Products from Forms: Products shall not be removed from the forms until the concrete reaches the compressive strength for stripping required by the design. If no such

requirement exists, products may be removed from the forms after the final set of concrete provided that stripping damage is minimal.

- G. Shipping Products: Products shall not be shipped until they are at least 5 days old, unless it can be shown that the concrete strength has reached at least 75% of the specified 28-day strength, or that damage will not be caused which will impair the performance of the product.

#### 2.7 SOURCE QUALITY CONTROL:

- A. Fabricate units in accordance with ACI 318 and the National Precast Concrete Association's Quality Control Manual for Precast Plants.

#### 2.8 ACCESS DOORS:

- A. Access doors shall be aluminum construction, AASHTO H5-20 rated. Door shall have compression spring assist opening mechanism, stainless steel hold open arms with positive locking, heavy duty hinges, lifting handles, and hasp. Doors shall be Holiday Products, series "H2W" or approved equal.

#### 2.9 SLEEVES:

- A. Sleeves shall be thickness Class 53 ductile iron pipe as specified in Section 02718. Encase sleeves per AWWA C105.

#### 2.10 LADDERS:

- A. Ladders shall be all aluminum, fully welded construction. Rungs shall be ribbed, slip resistant 1-3/8 inch diameter, spaced on 12 inch centers. Rails shall be 3/8" x 2-1/2" flat bar, spaced 16 inches apart. Mounting brackets shall offset the ladder 7 inches from the wall. Ladder shall be Holiday Products Model "L1B" series or approved equal.
- B. Provide telescoping extension rails that extend to 36 inches above the vault when extended.

### PART 3 EXECUTION

#### 3.1 GENERAL:

- A. The Contractor shall be responsible for providing adequate access to the site to facilitate hauling, storage and proper handling of the precast concrete products.
- B. Precast concrete products shall be installed to the lines and grades shown in the drawings.
- C. Products shall be installed per the precast manufacturer's recommendation.

#### 3.2 INSTALLATION:

- A. Precast concrete products shall be lifted by suitable lifting devices at points provided by the manufacturer.
- B. Set precast vault sections on a 6-inch compacted aggregate base course. The base course shall be compacted to a minimum of 100 percent of the maximum density as determined by ASTM D 1557. Install circular sections per Section 02221.
- C. Level precast units by altering the grade of the compacted subgrade, do not shim or block units to alter the grade.

- D. Install preformed flexible joint sealers or gaskets between all precast sections and between the cover and the bottom sections.
- E. All holes cut, cored, or drilled within the precast sections shall be in strict accordance with the manufacturer's recommendations.

3.3 PROTECTION:

- A. All precast tunnel sections shall be protected from damage during the construction of the steam tunnel and during the installation of piping within the tunnel.

3.4 ACCESS DOORS AND LADDERS:

- A. Install access doors and ladders per the manufacturer's recommendations.

END OF SECTION

SECTION 15010  
MECHANICAL GENERAL PROVISIONS

PART 1 GENERAL

1.1 SUMMARY:

A. Section Includes:

1. Description of Work
2. Manner of Performing Work
3. Codes, Permits and Connection Fees
4. Working in Confined Spaces
5. Applicable Publications
6. References
7. Definitions
8. Contract Drawings
9. Shop Drawings and Submittals
10. Record Drawings
11. Standard Products
12. Substitutions
13. Spare Parts Data
14. Protection of Materials
15. Scaffolding, Rigging and Access Demolition
16. Pipe Expansion and Contraction
17. Valve Tags, directories, Coding and Identification
18. Special Tools
19. Tests
20. Commissioning
21. Cleanup

B. Related Sections:

1. The General Conditions, Supplementary Conditions and Division 1, General Requirements apply to this Section, as well as all other Sections of Division 15, and Contractor shall review and adhere to all requirements of these documents.
2. The requirements of this Section 15010 apply to all Sections of Division 15.
3. Section 01300 – Submittals.
4. Section 01500 – Temporary Facilities and Utilities.
5. Section 01710 – Cleaning.

1.2 DESCRIPTION OF WORK:

- A. The requirements of this Section 15010 apply to all Sections of Division 15.
- B. Furnish all labor, equipment and materials necessary for the installation of the complete mechanical and plumbing systems as indicated on the drawings and hereinafter specified. This shall include all items of a minor nature necessary to complete this installation whether specifically mentioned in the contract documents or not.
- C. The Contractor shall inspect and examine the site, to verify the location of all utilities and to coordinate the location and lay-out of all new equipment, ductwork and piping. The drawings are diagrammatic and as such are not intended to show exact locations, sizes, nor complete installation requirements of mechanical systems.
- D. It shall be the responsibility of the Contractor to obtain all pertinent data regarding location of all existing utility lines in his area of operations. The Contractor shall make all necessary repairs and cause to be restored to service all active utility lines, of whatever nature, encountered and damaged in the source of excavation operations pertaining to his work.

1.3 MANNER OF PERFORMING WORK:

- A. Arrange, phase, and perform work to assure adequate services for the Owner at all times.
- B. Coordinate locations of piping, sleeves, inserts, hangers, ductwork and equipment with other trades. Locate piping, sleeves, insert, hangers, ductwork and equipment out of the way of windows, doors, openings, light outlets and other services and utilities.
- C. Cutting of holes through concrete and masonry shall be diamond core drill or concrete saw. Pneumatic hammer, impact electric, and hand or manual hammer type drills, will not be allowed, except as permitted by the Architect/Engineer. Holes shall be laid out in advance. If necessary to drill through structural sections, prior approval shall be obtained from the Architect/Engineer.
- D. Install gauges, thermometers, valves and other devices to afford visual, operating, and/or maintaining ease of said devices. Locate and position thermometers and gauges to be easily read by personnel standing on floor or walkway. Servicing shall not require dismantling adjacent equipment or pipe work.
- E. All materials and equipment shall be installed in accordance with the recommendations and guidelines issued by the respective manufacturers to conform to the contract documents. The installation shall be accomplished by workmen skilled in the trade involved.

1.4 CODES, PERMITS, CONNECTION FEES, ETC.:

- A. Install all work in strict accordance with laws, codes and regulations as required by authorities having jurisdiction thereto.
  - B. Secure and pay for all certificates, licenses, permits and other charges required to complete the mechanical work. See Division 0.
  - C. The Uniform Plumbing Code, latest edition, shall establish minimum requirements for plumbing work, unless otherwise specified. A copy of the code shall be retained at the job site.
  - D. The Uniform Mechanical Code, latest edition, shall establish minimum requirements for mechanical work, unless otherwise specified. A copy of the code shall be maintained at the job site.
- 1.5 WORKING IN CONFINED SPACES: (University of New Mexico)
- A. Whenever work is required within a confined space, e.g., utility vaults, utility tunnels, sumps, pits, sewers, etc., contact UNM Risk Management and Safety Department for details and procedures on UNM Confined Space Entry Program.
- 1.6 APPLICABLE PUBLICATIONS: The project shall comply with the latest edition of the following codes:
- A. New Mexico State Fire Code
  - B. New Mexico Commercial Building Code (this includes the International Building Code and International Existing Building Code)
  - C. Life Safety Code, NFPA 101
  - D. National Electrical Code
  - E. OSHA 1910, Regulations 29 CFR 1910 and 1926
  - F. Uniform Mechanical Code
  - G. Uniform Plumbing Code
  - H. N.F.P.A. in total
  - I. Americans with Disabilities Act
  - J. ASHRAE 90.1 – 89 and subsequent addenda
  - K. Air Conditioning and Refrigeration Institute (ARI)
  - L. Associated Air Balance Council (AABC)
  - M. International Association of Plumbing and Mechanical Officials (IAPMO)
  - N. American Water Works Association (AWWA)
  - O. American National Standards Institute (ANSI)
  - P. Underwriters' Laboratories (UL)
  - Q. Air Moving and Air Conditioning Association (AMCA)

- R. IAQ Guidelines for Occupied Buildings Under Construction (SMACNA)
- S. BSR/ASHRAE Standard 62-1989R
- T. ACGIH Industrial Ventilation Manual of Recommended Practices
- U. OSHA 29 CFR 1919.146 Confined Spaces Standard
- V. American Society for Testing Materials (ASTM)
- W. Sheet Metal and Air Conditioning Contractors' National Association (SMACNA)
- X. New Mexico Energy Conservation Code

1.7 DEFINITIONS:

- A. Where "as shown", "as indicated", "as detailed", or words of similar intent are used, it shall be understood that reference to the drawings accompanying these specifications is made unless stated otherwise. Where "as directed", "as required", "approved", "acceptance", or words of similar intent are used, it shall be understood that the direction, requirements, permission, approval or acceptance of the Architect/Engineer is intended unless stated otherwise. As used herein "Provide" shall be understood to mean "Provide in place", that is, "Furnish and install".
- B. "Piping" includes, in addition to pipe, all fittings, flanges, valves, hangers and other accessories related to such piping.
- C. "Concealed" means hidden from sight in closed chases, furred spaces, shafts, hung ceilings, or embedded in construction.
- D. "Exposed" means not installed underground or "concealed" as defined above. Tunnels, open trenches, accessible attic spaces and pipe chases, mechanical equipment rooms and built-up air handler interiors are considered exposed.
- E. "Singular Numbers" referring to a singular item shall mean all items so named in the event that more than one is required for the completion of the project.
- F. "Intent" means it is intended that the installation be complete and satisfactory for the operation required. Any omission of necessary accessories shall not mean that they are not required for the completion of the project.

1.8 CONTRACT DRAWINGS:

- A. Drawings indicate the general arrangement of the systems and are diagrammatic and do not necessarily show the exact locations of the piping, ductwork and equipment. Any major system rearrangement required by field conditions shall be approved by the Architect/Engineer before work is started.

1.9 SHOP DRAWINGS AND SUBMITTALS:

- A. Refer to section 01300 for submittal requests.
- B. Shop drawings and descriptive literature of all items of equipment and fixtures to be furnished; of all changes proposed to be made in piping, ductwork, etc., and of such other items as the Architect/Engineer may direct, shall be submitted for review. The reviews rendered by the Architect/Engineer of such documents shall not absolve the Contractor from the responsibility of any and all deviations required for the successful completion of the work unless such

deviations are called to the attention of the Architect/Engineer in writing for appropriate action. Errors in shop drawings and submittals shall be the responsibility of the Contractor.

- C. Submittal data shall include manufacturer's names, trade names, catalogs, model numbers, equipment selections, fully documented equipment performance ratings, nameplate data if applicable and all pertinent construction and descriptive specifications. Manufacturer's printed literature shall be utilized and equipment selections shall fall within the parameters of published recommended performance ratings. Under no circumstances will equipment of lesser capacity be accepted. Indicate selected equipment by crossing out or deleting non- applicable data.
- D. Refer to 15995 for additional submittal requirements for systems commissioning.

#### 1.10 RECORDDRAWINGS:

- A. Refer to Division 1 for record drawing requirements.
- B. Maintain a set of drawings at the job site and record thereon all installation changes which differ from contract drawings. Record exact locations of underground piping by dimension and invert depth. Indicate exact locations of all access panels and valves. Drawings shall be reviewed monthly. All changes shall be transferred to a new set of CAD Version 2000 files at the completion of the project and shall be identified as "record" drawings, signed sepias, and disks shall be delivered to the Architect/Engineer.
- C. The Contractor shall maintain a set of "record" specifications. The make and model number of each piece of equipment shall be annotated under the respective paragraph. The material and methods used for each piping system shall be indicated. The Contractor shall clearly review each paragraph within the specifications and annotate the project specifics for that item. The name and address of each supplier, equipment vendor or subcontractor shall be indicated under the respective paragraphs. The Contractor shall make three (3) copies of the annotated "record" specifications, each copy shall be hard bound with the name of the project engraved on the cover. All three (3) copies shall be transmitted to the Architect/Engineer. Prior to submitting the final copy of the record specifications, the Contractor will forward one copy marked up for the A/E's approval prior to binding.

#### 1.11 STANDARD PRODUCTS:

- A. All material and equipment furnished under these divisions of the specifications shall be standard catalog products of manufacturers regularly engaged in the manufacture of those products and shall essentially duplicate materials and equipment that has been in satisfactory use for at least two (2) years. Where two or more units of the same type are required, said units shall be the product of a single manufacturer. All materials and equipment shall be new, in first class condition and of the best quality for the purpose intended.

#### 1.12 SUBSTITUTIONS:

- A. Manufacturer's names and catalog reference numbers for equipment are specified herein and/or on the drawings. Competitive equipment equal in quality, usage, and space requirements may, subject to the requirements in Instruction to Bidders, be approved for substitution by the Architect/Engineer.
- B. Engineering designs and layouts are made around prime items specified. Items called out as "or equal" are considered products of an acceptable manufacturer but must be approved for substitution with regard to meeting usage, space requirements, and equivalence to prime specified items.



- C. Cost of all changes incurred by substitution of equipment shall be paid for by the Contractor making the substitution.
- 1.13 SPARE PARTS DATA:
- A. The Contractor shall furnish a list of spare parts for each different item of equipment in the approved list of materials and equipment. The foregoing shall not relieve the Contractor of any responsibility under the guarantee specified hereinafter.
- 1.14 PROTECTION OF MATERIALS:
- A. All materials and equipment, both in storage and installed, shall be fully protected against possible damage due to vandalism, negligence, inclement weather, etc., by the Contractor, during all phases of construction.
- 1.15 COMMISSIONING:
- A. Division 15 will be responsible to carry out the commissioning requirements specified in Section 15995.
- 1.16 TESTS:
- A. Furnish calibrated testing equipment and the services of competent, experienced Testing Engineers to conduct operating and performance tests specified. Instruments shall be calibrated prior to tests.
  - B. Prior to conducting formal tests, test and operate systems and equipment for no less than 48 continuous hours, to assure satisfactory performance during formal tests.
  - C. Conduct formal tests in presence of Architect/Engineer to demonstrate that all contract requirements are met. These tests shall include pressure tests for air, water condensate and steam systems, performance tests for all equipment and operating tests for systems.
  - D. Malfunctions in any tested system, piece of equipment or component part thereof that occurs before, during or as a result of tests, shall be corrected, repaired, and/or replaced at no additional cost to Owner and the tests repeated in presence of Architect/Engineer.
  - E. Further malfunction shall be similarly repaired and tests shall be repeated in presence of Architect/Engineer.
  - F. If completion of certain work or systems occurs at a time when final control settings and adjustments cannot be properly made to make a performance test, then such final control settings and adjustments for air handling systems and for heating systems respectively shall be made by the Contractor during first actual seasonal use of respective systems following completion of work.
  - G. Submit separate test reports for each applicable section under this division of the specifications.
  - H. Notify Architect/Engineer in writing a minimum of three (3) days before tests are to be conducted.
- 1.17 CLEAN-UP:
- A. All work, equipment and materials shall be cleaned of all debris, plaster, paint, etc., and upon completion of the project, shall be turned over to the Owner in a clean and first-class condition. All equipment, devices, piping, ductwork shall be completely wiped down and cleaned. All

equipment room floors shall be wet mopped. All debris resulting from work under this Division shall be removed.

1.18 WARRANTIES:

- A. In addition to the project two-year warranty, all equipment installed shall be warranted to meet specified performance requirements and to operate without excessive noise or vibration.

END OF SECTION

## SECTION 15050

### BASIC MECHANICAL MATERIALS AND METHODS

#### PART 1 GENERAL

##### SUMMARY:

###### A. Section Includes:

1. References
2. System Description
3. Submittals
4. Quality Assurance
5. Access Panels
6. Pipe Hangers, Inserts and Supports
7. Protection of Materials
8. Protection From Moving Parts
9. Belt Drives
10. Equipment Bases
11. Concrete Not Otherwise Specified
12. Scaffolding, Rigging, and Access Demolition
13. Excavation, Trenching, and Backfilling Not Otherwise Specified
14. Cutting and Patching
15. Pipe Sleeves
16. Electrolysis Protection
17. Painting Not Otherwise Specified
18. Nameplates
19. Valve Tags, Directories, Coding and Identifying Devices
20. Diagram and Mounting Board
21. Lubrication
22. Special Tools
23. Tests
24. Instructions
25. Maintenance Manual
26. Clean Up

###### 1. REFERENCES:

- ###### A. Reference Standards: Except as modified by governing codes and by the Contract Documents, comply with the applicable provisions and recommendations of the following:
1. For electrical equipment and products, comply with applicable National Electrical Manufacturers Association (NEMA) Standards, and refer to NEMA Standards for definitions of terminology herein.
  2. Comply with National Electrical Code (NEC) NFPA-70 for electrical installation requirements.
  3. Certified Pipe Welding Bureau (NCPWB) and American National Standards Institute (ANSI/ASME) Code Numbers B31.2 and B31.9 as applicable for welding requirements.
  4. Comply with American Society of Mechanical Engineers (ASME) American National Standards Institute (ASME/ANSI A13) for identification of piping systems.
  5. Comply with American Society of Mechanical Engineers (ASME) American National

Standards Institute (ANSI/ASME B31.1) Code For Pressure Piping.

2. SYSTEM DESCRIPTION:

- A. The Work includes, but is not limited to, the following:
  - 1. Materials and methods common to the work in general of Division 15 and other Divisions and Sections of the Specifications where referenced.

3. SUBMITTALS:

- A. Submit test reports as required in each separate Section of this Division 15 and in accordance with Shop Drawings and Submittals paragraph in Section 15010 and Section 01300 - Submittals.
- B. Submit Maintenance Manuals as described herein.
- C. Submit Shop Drawings and product data depicting the complete system for pipe hangers, inserts and supports.

4. QUALITY ASSURANCE:

- A. Welder Qualifications: Welding and Brazing shall be performed by an ASME Certified welder with current certificate in accordance with ANSI B31.1 for shop and project site welding of piping work. Refer to Sections 15060 and 15520 for Project Specific Welder qualifications.

PART 2 PRODUCTS

1. ACCESS PANELS:

- A. Access panels shall be Milcor, heavy gauge steel, complete with flush hinge door, coin operated cam lock, prime coat finish. Plaster frames shall be furnished where required. Panels shall carry a Class B Underwriter's Label.

2. PIPE HANGERS, INSERTS AND SUPPORTS:

- A. Acceptable Manufacturers:
  - 1. Hangers and inserts and supports shall be a complete system, as manufactured by Unistrut, ITT Grinnel, Fee & Mason, B-Line or approved equal.
- B. Hangers, inserts, and supports shall conform to Federal Specification WW-H-171 except as otherwise specified hereinafter. Hangers and inserts shall be as shown on drawings, or if not detailed on drawings, as specified hereinafter. Inserts shall be types 18 and 19 and shall be installed in correct locations before the concrete is poured. Beam clamps shall be types 20, 21, 22, 28, 29, 30, and 31. For piping up to and including 1-1/4" IPS, 3/4 inch wide, 18-gauge-minimum steel strap or ring-type hangers may be used and shall be secured by screw fasteners. Hangers in contact with copper tubing shall be coated to prevent electrolytic action. Hangers for insulated pipe shall have diameter large enough to include the covering and type 41 protective saddle shall be installed with each hanger. The location of hangers and supports shall be coordinated with the structural work to assure that the structural members will support the intended load.
- C. Provide required structural members, hangers, supports, and inserts to keep piping in proper alignment and prevent transmission of injurious thrusts and vibrations. All hangers and supports capable of screw adjustment after piping or conduit is erected shall be finally adjusted in vertical and horizontal direction under operating conditions. Hangers and supports shall be

spaced as indicated.

- D. Fabricated angle or Unistrut trapeze hangers may be used for piping less than 6" where several overhead pipes can be installed parallel at same elevation. Fasten each pipe firmly to hanger, with anchors or guides indicated.
- E. Protect pipe covering at each support with steel protection saddles or rigid insulation inserts and minimum 18 ga. shields that will transmit the load of the pipe line directly to the support without damage to the covering. Fill voids on steel saddles with insulation.
- F. Horizontal Piping: Hangers and supports for horizontal piping shall be installed at intervals specified on drawings or table below, at locations not more than 3 feet from the ends of each runout and not over 1 foot from each change in direction of piping. Hangers shall be as detailed on drawings or shall be adjustable type 1, 9, 11, or 12 with turnbuckles type 13 or 15. Brackets for support of piping at walls shall be type 32.

<u>Pipe Size</u>	<u>Spacing</u>	<u>Hanger Rod</u>	
1. Steel Pipe:	3"	12'-0"	1/2"
	4"	12'-0"	5/8"
	5"	12'-0"	5/8"
	6"	12'-0"	3/4"
2. Copper Pipe:	1/2"	6'-0"	3/8"
	3/4", 1"	8'-0"	3/8"
	1-1/4" through 2"	10'-0"	3/8"
	2-1/2"	12'-0"	1/2"

- G. In lieu of separate hangers, the Contractor may submit for approval a detailed drawing of trapeze hangers with turnbuckles on rods and a solid or split-ring clamp which he proposes to furnish for each pipe.
- H. Vertical Piping: Support shall be spaced as specified hereinafter. Pipe clamps shall be type 8 for floor supports and type 24 anchors at other locations.
  - 1. Cast iron and steel pipe shall be supported at each floor, at intervals of not more than 12 feet, and not more than 8 feet from end of riser.
  - 2. Copper tubing shall be supported at each floor, and between floors by stays or braces to prevent rattle and vibration.

**PART 3 EXECUTION**

**1. ACCESSPANELS:**

- A. Do not place valves, traps, controls, unions, water hammer arresters, dampers, coils, air distribution boxes, cleanouts, expansion joints, etc. in any system at a location that will be inaccessible after construction is completed. Maintain accessibility for all components in mechanical systems.
- B. Coordinate the exact location and size of all access panels to insure complete accessibility to all mechanical components. Label each access panel with plastic tag as hereinbefore specified.
- C. Indicate the location of access panels on the mechanical "record" drawings.

**2. PROTECTION OF MATERIALS:**

- A. All materials and equipment, both in storage and installed, shall be fully protected against possible damage due to vandalism, negligence, inclement weather, etc., by the Contractor, during all phases of construction.
- B. Interior of all pipe and duct stored on site shall be protected with end caps fabricated of plastic sheeting and duct tape.

3. PROTECTION FROM MOVING PARTS:

- A. Furnish and install protective guards for exposed moving machinery parts in accordance with New Mexico Industrial Safety Codes and OSHA.
- B. Guards for belt driven equipment shall be constructed with angle iron frames and diamond wire mesh enclosures. Provide shaft access openings for tachometer insertion.
- C. Guards for exposed shafts shall be galvanized sheet metal.

4. BELT DRIVES (not otherwise specified):

- A. Belts: Shall be "V" type. Provide for adjustment of both belt tension and alignment. Speeds shall not exceed 5,100 FPM.
- B. "V" belt size and sheave diameter:

"V" Belt Size Minimum Sheave (Motor or Equipment)  
Pitch Diameter-Inches

A	3.0
B	5.4
C	9.0
D	13.0
E	21.6

- C. "V" Belt Drives shall be rated at the HP of the motor plus 50 percent.
- D. Sheaves: Shall be statically and dynamically balanced, mechanically trued; pressed steel or close grained cast iron free of sand holes or defects. Sheaves for fan motors up to 25 HP shall be adjustable pitch. Calculate drive capacity on maximum pitch diameter setting, but select adjustable drive sheave so that pitch diameter at design conditions is midway between minimum and maximum setting of selected sheave.
- E. Multiple belts shall be matched. When replacement of one or more belts of a set is necessary, entire set shall be replaced with new matched belts. Multiple belts shall be designed to minimize whip, turn over and throw off. A permanent plastic or metal tag shall be attached to belt guard of each drive indicating manufacturer's model number, size and style of replacement belt sets.

5. EQUIPMENT BASES:

- A. All floor mounted equipment shall be installed on reinforced concrete bases, six inches high, with chamfered edges or as otherwise specified or shown on drawings, and attached thereto by bolts with inserts or expansion shields.

6. CONCRETE (not otherwise specified):

- A. All concrete furnished under this division and not elsewhere specified shall be 3000 psi

compressive strength. The forms, concrete materials and the placing thereof shall conform to the requirements of Division 3 of the specifications.

7. SCAFFOLDING, RIGGING AND ACCESS DEMOLITION:

- A. Provide all scaffolding, rigging, hoisting and services necessary for erection and delivery of all equipment and materials provided under this Division. Remove same from premises when no longer required.
- B. Access demolition may be required for the installation and/or removal of mechanical systems, piping and equipment. Access demolition not specifically noted on the contract documents will be at the discretion of, and only for the convenience of the Contractor; such work required shall not be used as a basis for requests for change orders or adjustments in the contract price. In areas where access demolition occurs, such areas shall be repaired or patched so as to match original and/or existing adjacent construction with no visible junction between existing and patched construction.

8. EXCAVATION, TRENCHING, AND BACKFILLING (not otherwise specified):

- A. If not elsewhere specified, do all excavating, trenching, backfilling, pumping, shoring, and trench protection that may be required for the installation of this work. Furnish all lights, guards, etc., required for safety. See Division 2 for requirements.
- B. Excavation shall be made only to such depth as may be necessary for the permanent installation of piping, ductwork, etc. Trenches dug below the required depth shall be refilled to proper depth with hard tamped sand.
- C. After work has been tested, inspected and approved, all excavations shall be backfilled with selected dirt, excluding rubbish and boulders, deposited in not to exceed six inch layers hand tamped, or twelve inch layers, air tamped. Compaction within the building shall be 95% of density, and outside the building 90% of density as determined in accordance with ASTM Designation D698. Underground duct shall be backfilled and compacted in accordance with manufacturer's recommendations.
- D. Backfilling shall be accomplished as promptly as possible after pipe or duct has been tested and approved, and all excess materials from excavation shall be removed from the site.

9. CUTTING AND PATCHING:

- A. Cut completed/existing construction where indicated or required, or if sleeves, openings, chases, etc. were inadvertently omitted, and only with the specific permission of the Architect/Engineer. In no case shall reinforcing steel or structural steel be cut without the written permission of the Architect/Engineer.
- B. Provide all sleeves, caps, plates, escutcheons, flashing, etc., required to fill or close the openings. Provide final grouting, concrete, asphalt, masonry, painting and other materials as required. Make repairs in like and kind for exact matching of surfaces and finishes.

10. PIPESLEEVES

- A. Pipe passing through concrete walls or slab shall be provided with pipe sleeves fitted into place at the time of construction, or openings for sleeves shall be cut or core drilled through existing construction. Sleeves shall not be installed in structural members except where indicated or approved by the Architect/Engineer. All rectangular or square openings shall be as required or detailed on drawings. Each sleeve shall extend through its respective floor, wall, or roof, and shall be cut flush with each surface. Unless otherwise indicated, sleeves shall be of such size to provide minimum of 1/4" all around clearance between bare pipe and sleeves or between

jacket over insulation and sleeves. Sleeves shall be steel or cast iron pipe. Except in pipe chases or interior walls, the annular space between pipe and sleeve or between jacket over insulation and sleeve shall be sealed or between jacket over insulation and sleeve shall be sealed. Metal jackets shall be provided over insulation passing through exterior walls, floors, or roofs, and shall be in accordance with SMACNA "Architectural Sheet Metal Manual". Annular space between pipe and sleeve in exterior walls shall be sized to allow installation of "link seal" mechanical seal, to be furnished as part of work.

- B. Pipes passing through roof, (or floor waterproofing membrane or not) shall be installed through a 4 pound lead-flashing sleeve, a 16 ounce copper sleeve, or a 0.032 inch thick aluminum sleeve, each with an integral skirt or flange. Flashing sleeve shall be suitably formed, and the skirt or flange shall extend not less than 8 inches from the pipe and shall set over the roof or floor membrane in a troweled coating or bituminous cement. The flashing sleeve shall extend up the pipe a minimum of 2 inches above the highest flood level of the roof or a minimum of 10 inches above the roof, whichever is greater. The annular space between the flashing sleeve and the bare pipe or between the flashing sleeve and the metal-jacket-covered insulation shall be sealed as specified hereinbefore. At the Contractor's option, pipes passing through roof or floor waterproofing membrane may be installed through a cast iron sleeve with caulking recess, anchor lugs, flashing clamp device, and pressure ring with brass bolts. Waterproofing membrane shall be clamped into place and sealant shall be placed in the caulking recess.
- C. Pipes penetrating floor into chiller room shall be installed in sch 40 steel sleeves welded to steel floor plate extending 4 inches above finish floor and sealed with firecaulk as shown on Details. Prime coat with rust inhibiting paint all sides prior to installation.
- D. Flashings for floor drains other than those installed in slab on fill shall be fabricated with 4 pound sheet lead, 30" square, clamped into drain flashing ring.
- E. Optional counterflashing as an alternate to caulking and sealing the annular space between the pipe and flashing sleeve or metal-jacket-covered insulation and flashing sleeve, counterflashing may be accomplished by utilizing:
  - 1. A standard roof coupling for threaded pipe up to 6" in diameter.
  - 2. A lead flashing sleeve for dry vents extending up and down into the pipe to form a waterproof joint.
  - 3. A tack-welded or banded-metal rain shield around the pipe and sealed as indicated for Joint Shape FRW.
- F. Fire-Rated Seals: Where pipes pass through fire-rated partitions, or floors, a fire seal of mineral wool, or similar noncombustible materials shall be placed behind the backup materials.

#### 11. ELECTROLYSIS PROTECTION:

- A. Sheet Metal: Where aluminum is in contact with masonry or concrete, it shall be insulated by a heavy coat of alkali resistant asphaltic or bituminous paint applied to both surfaces and allowed to dry before assembly or installation.
- B. Piping: Dielectric fittings such as couplings, unions or flanges, shall be installed to isolate pipe connections between non-ferrous and ferrous metals. Isolation shall be accomplished by non-metallic, unthreaded sleeves or gaskets or a combination of both. Fittings shall be so designed that the installing tools cannot come in contact with the insulating material. Materials shall withstand system pressure and temperature as required.

#### 12. PAINTING:

- A. After installation, clean equipment and accessories having factory primed or finished painted surfaces, and touch-up bare or marred spots with same paint as applied at factory. When this



is not available, obtain complete description of the paint so that an exact duplicate may be procured locally. Repair and refinish all finished surfaces scuffed or damaged by installation of work under this Division.

13. NAMEPLATES:

- A. Each and every manufactured component furnished for the project shall bear a permanently affixed nameplate stating the manufacturer's name, component model number and where applicable, rated performance characteristics. Supplier or agency nameplates will not be acceptable. Manufacturer's data which is cast into, stamped upon or otherwise permanently marked upon the equipment will be acceptable.
- B. Additionally, each piece of equipment, i.e., pumps, heat exchangers, etc., shall be labeled with a 1" high, 1/4" thick laminated plastic plate provided with engraved white core letters 3/8" high. Plates shall be color coded to indicate service. Nameplates shall bear notations corresponding to notations on the contract documents and the operating instructions. Secure plates to equipment with vandal proof screws or, where impossible to do so, with 8" or 12" braided copper wire meter seals.

14. VALVE TAGS, DIRECTORIES, CODING AND IDENTIFYING DEVICES:

- A. Identify all mechanical equipment as herein specified in Division 15.
- B. All valves (except fixture stops) shall be tagged with 1-1/2 inch diameter brass discs having depressed black filled letters and numbers. Identifying numbers shall be no less than 1/2 inch high and letters no less than 1/4 inch high. Numbers shall conform with valve directory listing number, location and use.
- C. Color code tags red, blue, green, etc. to indicate fluids controlled by valves.
- D. Secure all tags to valves with 12" long braided copper wire meter seals.
- E. Provide valve directories framed under acrylic and aluminum frame containing the following data: Valve number, service, location, size, type, make, model, normal position and special remarks. Mount in each equipment room and provide three unframed copies of each to the Owner.
- F. Stencil identification labels and flow arrows on all pipe and ducts after finish painting is completed. Place labels at sufficient intervals throughout the systems, adjacent to valves and fittings, at each change of direction and no more than 40 feet apart. In concealed areas provide identification at all access panels including access in removable tile ceilings. In finished areas, label exposed pipe or ducts only as directed by Architect/Engineer. Size of stencil letters per ASA-A 13.1 except that identification tags may be used when outside diameter of pipe or covering is less than 1-inch. All stencils shall be readable from floor level.
- G. Piping insulation is to be labeled non-asbestos containing.

15. DIAGRAM AND MOUNTING BOARD:

- A. Shall be of sturdy construction with frame of stainless steel and front of 1/8" clear acrylic plastic. Furnish and mount therein, single line schematic diagrams of piping pertaining to systems, automatic temperature controls, and other installed systems, and indicate control accessories and auxiliaries. Each element shall be named or numbered with nomenclature and/or numbers used to identify equipment on diagram or flow sheet.
- B. Flow diagrams shown on contract drawings may be used, if applicable, and approved. Diagrams shall indicate final system flows pressure, system head, pressure and temperature

parameters and motor horsepowers. Values shall be taken from balance reports.

- C. The diagram drawing shall be a permanent photographic reproduction, approximate size 28" x 18".

16. LUBRICATION:

- A. Lubricate as required, all motors, bearings, fans, etc. before equipment is put into operation.
- B. Provide lube extension fittings where required for ease of maintenance. Install all motors and bearings so that oil fill ports are vertical. Rotate motor end bells as required.
- C. Provide a final lubrication for all equipment requiring same immediately before turning over to the Owner, submit certification.

17. SPECIAL TOOLS:

- A. If any part of equipment furnished under these specifications requires a special tool for assembly, adjustment, setting or maintenance thereof and such tool is not readily available on the commercial tool market, it shall be furnished with equipment as standard accessory.
- B. Prior to starting construction in any area, the Contractor shall notify the Architect/Engineer of any special hoisting or lifting device which might be needed to facilitate mechanical equipment maintenance and/or removal.

18. TESTS:

- A. Furnish calibrated testing equipment and the services of competent, experienced Testing Engineers to conduct operating and performance tests specified. Instruments shall be calibrated prior to tests.
- B. Prior to conducting formal tests, test and operate systems and equipment for no less than 48 continuous hours, to assure satisfactory performance during formal tests.
- C. Refer to section 15995 for testing required for systems commissioning.

19. MAINTENANCE MANUAL:

- A. Shall be a complete, detailed guide for maintenance and operation of the new equipment and systems. It shall include an index covering equipment and accessories, and shall be keyed throughout to the diagrams. The index shall be arranged in the same order as the Project Specifications, with each item keyed to section and paragraph number. Manual shall contain manufacturer's printed data and shall be sufficiently broad to serve operating staff as a permanent set of instruction which they can rely upon to understand the general theory and concept of the systems and to assist them in making operating maintenance adjustments.
- B. The manual shall contain, as a minimum, complete installation, operation and maintenance instruction books, complete parts lists and catalogs, as well as detailed descriptions of special precautions, sequence of assembly and disassembly, and recommendations as to methods of adjustment of all parts requiring adjustment, a list of recommended spare parts complete with price lists for each piece of equipment supplied under the contract, and a list of special tools and cases complete with manufacturer's listed prices.
- C. All final approved Contractor-furnished drawings, submittals and data shall be included and all shall be reduced to 11 inches high.
- D. The Contract equipment designations and numbers shall be marked on each piece of literature

and all non-relevant information shall be deleted. Key each to specification section and paragraph.

- E. A complete detailed "Cold Start-Up" procedure for all systems and equipment in the form of a comprehensive written narrative.
- F. Modes of operation for all pumping systems and/or summer-winter operation selection and control of water temperatures and pressures in various modes.
- G. Pertinent schematic piping and duct drawings to adequately define the limits and capabilities of each system. These drawings could be the same that are used for construction. The testing and balancing contractor shall record actual operating conditions thereon, i.e., flows, pressures, pressure drops. These drawings shall also indicate the location of pressure relief valves (including set pressures) and flow measuring and adjusting devices.
- H. Provide "record" piping diagrams for instrument air used for automatic temperature control shall be required from the control manufacturer and included for operational and maintenance purposes.
- I. Provide "record" schematic wiring diagrams for the electrical interlock of all mechanical equipment and interface points with the automatic temperature control systems.
- J. Additional items to be included as attachments shall be the test reports and certifications on items required by Division 15 of the specifications.
- K. Furnish ten copies.

20. CLEAN-UP:

- A. All work, equipment and materials shall be cleaned of all debris, plaster, paint, etc., and upon completion of the project, shall be turned over to the Owner in a clean and first-class condition. All equipment, devices, piping, ductwork shall be completely wiped down and cleaned. All equipment room floors shall be wet mopped. All debris resulting from work under this Division shall be removed.

END OF SECTION

## SECTION 15060

### UTILITY PLANT PIPING AND VALVES (CHILLED WATER, CONDENSATE WATER, HEATING WATER, SIDE STREAM FILTRATION, REFRIGERANT RELIEF, COMPRESSED AIR, MAKE UP WATER, MISCELLANEOUS SERVICE WATER)

#### PART 1 GENERAL

##### 1.1 SECTION INCLUDES:

- A. Related Sections.
- B. References
- C. System Description
- D. Submittals
- E. Project Record Documents
- F. Operation and Maintenance Data
- G. Qualifications
- H. Project Specific Pipe Welder Qualification Procedure
- I. Regulatory Requirements
- J. Delivery, Storage and Handling
- K. Extra Materials
- L. Pipe, Fittings and Valves
- M. General Installation
- N. Welding of Steel Pipe
- O. Screwed Pipe
- P. Pitching Pipelines
- Q. Risers and Conduits
- R. Equipment Connections
- S. Pipe Installation
- T. Pipe Fittings
- U. Tests
- V. Cleaning Pipe Systems
- W. Valves:
  - 1. Butterfly valves.
  - 2. Ball valves.
  - 3. Check valves.
- X. Automatic valve actuators.

##### 1.2 RELATED SECTIONS:

- A. Section 08305 - Access Doors.
- B. Section 09900 - Painting.
- C. Section 15190 - Mechanical Identification.
- D. Section 15260 - Piping Insulation.
- E. Section 15515 - Hydronic Specialties.
- F. Section 15520 – Steam and Condensate Piping and Valves
- G. Section 15525 – Steam and Condensate Specializing
- H. Section 15545 - Chemical Water Treatment: Pipe cleaning.

##### 1.3 REFERENCES:

- A. ASME - Boiler and Pressure Vessel Codes, SEC 9 - Qualification Standard for Welding and Brazing Procedures, Welders, Brazers, and Welding and Brazing Operators.
- B. ASME B16.3 - Malleable Iron Threaded Fittings Class 50 and 300.

- C. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings.
- D. ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
- E. ASME B31.9 - Building Services Piping.
- F. ASTM A53 - Pipe, Steel, Black and Hot-Dipped, Zinc Coated Welded and Seamless.
- G. ASTM A234 - Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures.
- H. ASTM B32 - Solder Metal.
- I. ASTM B88 - Seamless Copper Water Tube.
- J. ASTM F708 - Design and Installation of Rigid Pipe Hangers.
- K. AWS A5.8 - Brazing Filler Metal.
- L. AWS D1.1 - Structural Welding Code.
- M. MSS SP58 - Pipe Hangers and Supports - Materials, Design and Manufacture.
- N. MSS SP69 - Pipe Hangers and Supports - Selection and Application.
- O. MSS SP89 - Pipe Hangers and Supports - Fabrication and Installation Practices.

1.4 SYSTEM DESCRIPTION:

- A. Chilled water, condenser water, heating water, compressed air, side stream filtration, vent and relief lines, refrigerant relief, make up water, and miscellaneous service water piping within tunnels and mechanical rooms.
- B. Where more than one piping system material is specified, ensure system components are compatible and joined to ensure the integrity of the system is not jeopardized. Provide necessary joining fittings. Ensure flanges, union, and couplings for servicing are consistently provided.
- C. Use unions, flanges, and couplings downstream of valves and at equipment or apparatus connections. Do not use direct welded or threaded connections to valves, equipment or other apparatus.
- D. Use non-conducting dielectric connections whenever jointing dissimilar metals in open systems.
- E. Provide pipe hangers and supports in accordance with ASTM/ASME B31.9 unless indicated otherwise.
- F. Use ball or butterfly valves for shut-off and to isolate equipment, part of systems, or vertical risers.
- G. Use globe ball or butterfly valves for throttling, bypass, or manual flow control services.
- H. Use vertical check valves on discharge of pumps as indicated on drawings.
- I. Use only butterfly valves or ball valves for pipe less than 2-1/2 inches in chilled and condenser water systems for throttling and isolation service.
- J. Use lug end butterfly valves to isolate equipment, and in all other applications. Wafer style butterfly valves shall not be used.
- K. Use 3/4 inch ball valves with cap for drains at main shut-off valves, low points of piping, bases of vertical risers, and at equipment.

1.5 SUBMITTALS:

- A. Submit under provisions of Section 01300.

- B. Product Data: Include data on pipe materials, pipe fittings, valves, and accessories. Provide manufacturers catalogue information. Indicate valve data and ratings.
- C. Welders Certificate: Include welders qualifications and certification of compliance with ASME SEC 9 as described in this section.

- D. List of Project Specific Certified Welders and identification symbols.

- E. Spool drawings shall be provided by the Contractor and submitted for Engineer review prior to any field or shop fabrication. Spool drawings to be isometric drawings showing pipe, hanger location and equipment connections with critical dimensions indicated. Hand drawn sketches on 8 1/2" x 11" paper are acceptable provided they are legible, dated and signed by contractor.

- F. Manufacturer's Installation Instructions: Indicate hanging and support methods, joining procedures.

- G. Cleaning and testing certificates.

1.6 PROJECT RECORD DOCUMENTS:

Record actual locations of valves and actual locations of all underground pipe with horizontal dimension from building corners and vertical dimension of invert from finish grade.

1.7 OPERATION AND MAINTENANCE DATA:

Maintenance Data: Include installation instructions, spare parts lists, exploded assembly views.

1.8 QUALIFICATIONS:

- A. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.
- B. Installer: Company specializing in performing the work of this section with minimum three years documented experience.
- C. Welders: Certify in accordance with ASME SEC 9, and as indicated herein.

1.9 PROJECT SPECIFIC WELDER CERTIFICATION PROCEDURE:

- A. All welding shall be in accordance with ASME B31.1 (latest edition).
- B. All workers performing pipe welds for this project, either in off site shop fabrication or in field assembly shall be certified to a set of job specific Welding Procedure Specifications (WPS) as described below.
- C. The contractor will prepare and qualify the Welding Procedure Specification for the type and grade of pipe to be used in representative size indicated below:
  - 1. 12" pipe weld for CW, CHW, refrigerant relief and side steam filter.
- D. The individual qualifications of the workers shall be performed by an Independent Testing Agency approved by the owner. The individual qualifications will be done on the project job site, in an area established by the contractor, and using the contractors equipment and materials.

- E. The contractor shall be responsible for scheduling the Project Specific Certification testing with the Independent Testing Agency and shall provide the owner with 48 hour advance notice and allow owners representative to witness the testing procedure.
- F. The contractor shall include all costs associated with preparation and qualification of welding procedures, certification of welders Independent Testing Agency fees in his bid.
- G. Following certification, the contractor shall provide each welder with a unique stamp employing letters a minimum of 1/4" high. Each and every pipe weld or braze installed on this project shall be stamped. Contractor shall submit list of welders and their marks prior to commencing any work and provide monthly updates of names and stamp identification for all pipe welders working on this project.
- H. Unstamped welds will be rejected and replaced by project specific certified personnel at no additional cost to owner.

1.10 REGULATORY REQUIREMENTS:

- A. Conform to ASME B31.9 code for installation of piping system.
- B. Welding Materials and Procedures: Conform to ASME SEC 9.

1.11 DELIVERY, STORAGE, AND HANDLING:

- A. Deliver, store, protect and handle products to site in accordance with manufacturer's recommendations.
- B. Accept valves on site in shipping containers with labeling in place. Inspect for damage.
- C. Provide temporary protective coating on cast iron and steel valves.
- D. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.
- E. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.
- F. Unload, store and place Owner furnished equipment.

1.12 EXTRAMATERIALS:

Provide two repacking kits for each size valve and valve type for all valves with packing.

PART 2 PRODUCTS

2.1 PIPING, FITTINGS AND VALVES:

- A. General: All piping not covered by a specific code shall conform to the pressure piping standards of ANSI/ASME B31 unless otherwise noted. Schedule number, sizes and dimensions shall conform to ANSI/ASME B36.10 and weld and preps to ANSI/ASME B16.25.

2.2 STEEL PIPE:

- A. Section applies to:
  1. Chilled Water.
  2. Condenser Water.

3. Heating Water (including Glycol/Water).
  4. Side Stream Filtration.
  5. Miscellaneous Building Service Water.
  6. Refrigerant Relief.
  7. Compressed Air Greater than 1-1/4".
  8. Relief and vent lines through roof.
- B. Steel pipe 14 inches and below: ASTM A53 Gr-B Sch 40, seamless, black, domestic.  
Steel pipe 16 inches and above: ASTM A53 Gr-B STD weight, ERW, black, domestic.
- C. Pipe Fittings:
1. 2" and smaller shall be malleable iron, 150 lb. class, screwed, ANSI B16.3
  2. 2-1/2" and larger shall be forged carbon steel, butt weld, wall thickness equal to standard weight pipe, ANSI B16.9. Welding fittings shall conform to class of pipe on which installed and shall have beveled ends for butt welding with radius of elbows not less than normal diameter of corresponding pipe and long radius unless otherwise indicated. Tees shall be full size or reducing as required, having interior surfaces smoothly contoured. Tees shall be forged or fabricated from longitudinally welded rolled cylinders. Fabricated tee branches shall be extended and stress relieved per ASTM A 234-84a. Saddling or field fabricating of branches shall not be accepted Forged tees shall be Tube Turns #21 or approved equal. Welding outlet fittings shall be ASTM A 105 GR2, forged integrally reinforced to provide 100 percent pipe strength, beveled for full penetration welding and funneled at inlet for full fluid flow. Connection outlet fittings shall be Weld-o-let or Thread-o-let or approved equal. Pipe fittings shall be domestic manufacturer. No hand or field fabricated fittings will be approved.
- D. Flanges: Shall be weld neck, raised face ANSI B16.5 unless otherwise indicated or approved. Flanges to have pressure class, size, hole pattern and facing to match mating equipment flanges. 150 lb. class unless otherwise indicated. Steel flanges mating to ductile flanges shall be flat face.
- E. Gaskets: Compressed fiber gaskets shall be used on raised flanges in systems operating below 225 F and shall be in accordance with ANSI B16.21. Materials shall be suitable for a maximum pressure of 300 psi and a maximum working temperature of 225 F. Gaskets for plain, finished surfaces shall be not less than 1/16 inch thick and for serrated surfaces shall not be less than 3/32 in thick. Garlock Bluegaurd or approved equal.
- F. Bolting:
1. Bolting shall conform to the requirements of ANSI B15.5. All bolt and nut threads shall conform to ANSI B1.1. Alloy steel bolting shall be used for joining all raised face steel flanges having a design pressure Class 150 psi or greater, and the material shall conform to the following:

Bolting studs and bolts	ASTM A 193 Grade B7
Nuts	ASTM A 194 Grade 2H
  2. Carbon steel bolting shall be used for joining all flat faced and other iron and steel flanges. Bolts and nuts shall be heavy hexagonal head and the material shall conform to the following:

Bolting studs and bolts	ASTM A 307 Gr B
Nuts	ASTM A 563 Gr A



3. Buried bolting shall be cadmium-plated in accordance with ASTM A 165 or zinc-coated in accordance with ASTM A 153.
4. Bolting in non-ferrous flanges and flanged fittings shall conform to the following:
 

Bolting studs and bolts	ASTM A 307 Gr B, Cadmium-plated
Nuts	ASTM B 16
5. Thread lubricant shall be used as required.

2.3 COMPRESSED AIR 1 1/4 INCH AND SMALLER:

- A. Copper tubing: ASTM B88 Type L, Hard drawn.
- B. Fittings: ASME B16.18, Cast brass or ASME B16.22 solder wrought copper.
- C. Joints: Solder, lead free 8% silver content Silva Brite \* or equal Braze, AWS A5.8 BCuP silver/phosphorous/copper alloy with melting range 1190-1480 degrees F.

2.4 EQUIPMENT AND PIPE DRAINS AND OVERFLOWS, BLOWDOWN, AND COOLING TOWER MAKE UP WATER ABOVE GRADE:

- A. Steel Pipe: ASTM A53 SCH 40, Galvanized.
- B. Fittings: Galvanized Threaded.
- C. Joints: Threaded.

2.5 CPVC PIPE:

- A. Use for: Condenser water pipe inside cooling tower enclosure, side steam filter piping inside cooling tower enclosure.
- B. CPVC pipe and fittings shall be manufactured in accordance with ASTM D1785 and ASTM F-441. Pipe shall be Type 1 Grade 1 in accordance with ASTM D1784.
- C. CPVC pipe and fittings shall meet dimensional tolerance requirements. Fittings shall be injection molded of CPVC Fitting Compound of cell classification 12447-B as described in ASTM D-1784.
- D. Solvent welding of CPVC shall be done in strict accordance with manufacturers recommendations using materials explicitly recommended by pipe manufacturer. Solvent welding of CPVC pipe shall only be done when ambient temperature exceeds 45 °F.
- E. Submit data sheets on pipe, fittings and solvents with manufacturers explicit statement of compatibility, and manufacturers written instruction booklet.

2.6 UNIONS:

- A. Unions for pipe 2 inches and smaller.
  1. Ferrous Pipe: 150 psig malleable iron, threaded.
  2. Copper Pipe: Bronze, soldered joints.
- B. Dielectric Unions: Union with galvanized or plated steel threaded end, copper solder end, water impermeous isolation barrier.

2.7 VALVES:

A. General:

1. Each type shall be of one make and each valve shall have name or trademark of manufacturer together with working pressure indicated on body. Flanged valves in welded lines shall have weld type companion flanges conforming to ANSI B16.5. Design valve bodies for a working pressure of not less than 150 psi or 150% of the system operating pressure, whichever is greater. Valves 6 inches and larger in size shall be gear operated with hand wheel. Chain wheel operators and chains shall be provided for all manual valves located 8 or more feet above floor. Butterfly valves shall be used in water lines in sizes 2-1/2 inches and larger. Unless otherwise indicated, ball valves shall be used on all lines 2 inches and smaller. Valves shall be installed with stem in no lower than horizontal position unless expressly approved by Engineer. Position indicators shall be provided for all gear operators.
2. Install valves at all connections to equipment and elsewhere as may be indicated for complete control or isolation of any piece of equipment or service to branch lines. Position valves in accessible location and of same size as piping.
3. Provide like type valves of one manufacturer only unless specified otherwise.
4. Plainly and permanently mark valves with manufacturer's name or trademark, pressure rating, Water, Oil and Gas (WOG) and flow direction when required to prevent improper installation.
5. Replacement of valve parts shall be accomplished with valve in the line, or through use of a union downstream at valves less than 2-1/2 inches.
6. Provide extended necks as appropriate for insulation.

B. Manufacturers:

1. The following manufacturers are acceptable provided that the product is equivalent in every respect to the nomenclature provided Crane, Centerline, GA Industries, Keystone, Milwaukee, Nibco.

C. Butterfly Valves:

1. Iron Body, Lug Type, Flanges to mate with raised face steel flanges.
2. Resilient Seated Replaceable EPDM seat: Bi-directional, drop tight shutoff.
3. Upper and lower bushings of acetal (2-20") or bronze (greater than 20").
4. Bronze disk with on piece 316 stainless steel shaft and bronze bushings.
5. Provide secondary shaft seals.
6. Keystone #AR-2 or prior approved equal.

D. Ball Valves:

1. Screwed bronze body, 150#.
2. Full throated, 2 piece.
3. Stainless steel ball and trim
4. Teflon seats and stuffing ring.
5. NIBCO or equal.

E. Check Valve:

1. Check valve shall be spring-loaded, center guided disk design permitting flow in one direction only. The valve shall close tightly, without slamming prior to reversal in flow occurring.
2. The check valve shall open when the inlet pressure increases approximately  $\frac{1}{4}$  to  $\frac{1}{2}$  psi above downstream pressure. Valve shall maintain drop tight shut off.
3. Cast Iron Body: Bronze disc, with bronze guide bushings. Resilient Buna-N seat.
4. GA Industries Fig 290-D or equal.

2.8 PNEUMATIC VALVE ACTUATORS:

- A. Rack and Pinion type actuator with output drive designed for direct mating to valve stem.
- B. Double acting actuator with 13,000 lb-in at 120 psig designed to meet closing duty of largest valve in system with 80 psi supply air.
- C. Provide solenoid valves, limit switchbox, positioner, declutchable manual override gearbox and high visibility indicator.
- D. Provide feedback positioner with integral 4-20 in mA output signal, and NEMA 4X remote mounted transmitter.
- E. Keystone pneumatic actuator Fig 79U and Tyco AVID SmartCal Intelligent Positioner.
- F. Includes installation of pressure gage and last 12 inches of pneumatic supply air using hand drawn copper.

2.9 COOLING TOWER FLOAT VALVES:

- A. 2 inch modulating cast steel globe float valve. 200 psig pressure. Designed for dead end service.
- B. Rod shall be stainless steel, length to match extension application.
- C. Provide float and counter weight adjustable from 1-40 inches;
- D. Keckley No. 7 or approved equal.

PART 3 EXECUTION

3.1 GENERAL INSTALLATION:

- A. All materials and equipment shall be installed in accordance with the approved recommendations and guidelines as issued by the respective manufacturers to conform with contract documents. The installation shall be accomplished by workmen skilled in the trade involved.
- B. Install gauges, thermometers, valves and other devices and equipment to facilitate ease in reading or operating and maintaining said devices. Locate and position thermometers and gauges for easy readability by operator or staff standing on floor or walkway provided. Servicing shall not require dismantling adjacent equipment or pipe work.
- C. Follow piping arrangement and details, cut piping accurately to measurements established at site and installed without spring or forcing. Unless otherwise indicated, piping shall be aligned to be parallel to building lines. Vertical piping drops shall be plumb. Locate piping and equipment

to avoid interference with other piping and equipment including openings, electrical conduits and outlets. Make suitable provisions for expansion and contraction with pipe offsets. Piping shall conform to ANSI Code for Pressure Piping. For roof mounted pipe support provide pitch pockets.

- D. Provide small piping required in connection with instruments, gauges, reducing valves, traps and other mechanical equipment not indicated on drawings. Provide drains, shut-off valves and cocks, syphons, and pulsation dampers.
- E. Connect new work to existing work in a neat and workmanlike manner. Where an existing surface must be cut, or existing utilities interfere, such obstructions shall be bypassed, removed, replaced or relocated, patched and repaired. Work disturbed or damaged shall be replaced or repaired to its prior condition at no additional cost. Replaced or relocated piping shall be of the same material, type, class and size as the existing, unless otherwise approved.

### 3.2 WELDING OF STEEL PIPE:

- A. The Contractor shall inform the Owner's Construction Representative a minimum of 48 hours in advance of any intended welding operations inside or within 100 feet of the building or tunnel, and shall provide a fire guard and a suitable fire extinguisher at the welding site at all times when welding is in progress.
- B. When working in utility tunnels or similar spaces, contractor shall provide supply exhaust fans and any temporary sheet plastic draft stops necessary to prevent fumes from contaminating owners occupied space. Work within tunnels shall be accomplished in compliance with OSHA Guidelines. Draft stop location and details, along with worker safety plan shall be reviewed with owner prior to commencement of any welding work.
- C. Before assigning any welder to work, the Contractor shall provide certification to the Owner as herein before indicated.
- D. Contractor shall weld ferrous pipe 2-1/2 inches and larger. Branch connections 2-1/2 inches and larger shall be made with welding tees. Pipe bends made with two-1/2 mitre welds, field fabricated fittings including laterals, shaped nipples and tees, altering of flanged tees, notching straight runs to form tees or any other similar type of construction is not acceptable unless otherwise explicitly specified. "Weld-O-Lets" or similar fittings may be used provided that the entire root of the fitting is completely filled with weld material so that the circumferential root is filled flush with the outside surface of the fitting. This requires multiple welding passes. Steel butt-welding fittings shall be as strong or stronger than the pipe schedule number specified.
- E. Welded pipe connections shall be done by electric-arc welding, and shall conform to the recommendations and rules of the Standard Manual on Pipe Welding, published by the Mechanical Contractor's Association, the American Welding Society, and applicable portions of the ASME Boiler and Pressure Vessel Code. Electrodes for welding shall conform to ASTM A-233, and shall be one of the following classes: E6010, E6011, E6016, or E6020.
- F. Contractor shall be responsible for the proper storage of all welding rod, electrodes, and filler metal (i.e., storage of low hydrogen type electrodes in heated ovens).
- G. Preheat welding area to "hand-hot" if ambient temperature is below 32°F.
- H. All welds are subject to inspection by the Owner's Construction Representative. Non Destructive Evaluation (NDE) including dye penetration and/or radiographic testing by an independent testing laboratory, may be done at Owner's option. Costs for initial testing will be borne by owner. If the weld is not satisfactory, the unacceptable area will be removed and rewelded by the Contractor, at no additional cost to the Owner. Costs for retesting of the weld will be borne by contractor.

3.3 SCREWED PIPING:

- A. Shall have clean cut threads with joints made-up with oil and graphite pipe joint compound or graphite compound compatible for use for intended service. Apply to male threads only. Screwed joints, where required, shall be made with PTFE tape, Mil. Spec. MIL-T-27730.

3.4 PITCHING PIPE LINES:

- A. Pitch pipe lines for proper drainage and elimination of air and provide vents at the high points.
- B. Pitch circulating water piping upward in direction of flow not less than 1 inch in 40 feet.
- C. Run overhead piping to provide as much headroom as possible.

3.5 RISERS AND CONDUITS:

- A. Run all piping and conduits parallel to lines of building, with at least one inch clearance from insulated or bare pipe to finished wall unless restricted by structural conditions.

3.6 EQUIPMENT CONNECTIONS (WATER):

- A. Provide appropriate water connections to all heat transfer coils, related equipment and other hydronic equipment and appurtenances.
- B. Branch or runout connections for up-feed risers and horizontal runouts shall be taken from top of supply and return mains with swing connections, 45 degree fittings or tees. Branch or runout connections for down-feed risers and horizontal runouts shall be from bottom of horizontal supply and return mains. Branch or runout connections in elbows will not be allowed.
- C. Install air vent valves with ball valve cocks at every high point in each hydronic flow system and top of each coil or heat exchanger for complete removal of entrapped air.
- D. Install drain cock or valve at every low point in each hydronic flow system and ball valve at the bottom of each coil or heat exchanger for complete drainage of system and related equipment. Include hose bib with cap at drain connections
- E. Install shut-off valves and unions or flanges on supply and return lines for each coil, heat exchanger or other piece of equipment or as indicated. The use of start up strainers is required on all equipment being installed with tight tolerances

3.7 PIPE INSTALLATION:

- A. Before installation, thoroughly clean the inside of all pipe, fittings, valves of dirt, scale, sand and other foreign materials. Close ends to protect against entry of concrete, plaster, mortar, etc., after pipe is cleaned.
- B. Make all offsets, changes in direction, branch connections and changes in size with fittings, using no bushings.
- C. Unless specifically detailed otherwise, run piping parallel with the lines of the building or tunnel structure. Vertical piping and drops shall be plumb.
- D. Make all connections to equipment so that the weight of the piping does not rest on the equipment. Provide floor stands and/or hangers to carry piping weight. Make final connections to all equipment so that equipment may be removed without disturbing piping. Pipe found to spring by more than 1/8" will be replaced by Contractor. Provide unions in pipe 2" and smaller.

Provide bolted flanges in pipe 2-1/2" and larger.

3.8 PIPEFITTINGS:

- A. Cutting: Cut all pipe with wheel cutters or saw and carefully ream to remove all burrs. Make cuts clean and at right angle to axis of pipe. Cut all pipe accurately to measurements determined at the point of work and install in place without springing or forcing.
- B. Threaded Joints: Cut threads on screwed pipe with sharp clean dies so that no more than two threads are left exposed on the pipe when the joint is made-up. Ream out ends of threaded pipes full size with long taper reamer to provide a perfectly smooth partial bell mouth. Make-up joints in threaded piping with graphite base pipe compound completely covering the male thread, except joints in cleanout plugs shall be made with red lead and boiled linseed oil, or Acorn Number 3500 emulsified lead paste.
- C. Welded Joints: Make-up welded joints in accordance with Chapter Four, Section 6 of the ASME Code for Pressure Piping, using arc welding. Weld joints with continuous welds on beveled pipe ends.
- D. Solder Joints: Cut tubing with square ends, remove all burrs, fins and dents and resize if necessary. At each joint, mark tubing with scribe line one inch plus the depth of the socket, measured from the end of the tubing and clean tubing and socket with solvent, then clean with emery cloth. Coat tubing end and inside of socket with thin film of flux, insert tubing full depth into socket and twist to spread flux. Heat socket to correct temperature to melt solder, remove flame, apply solder to edge of socket or to solder hole and completely fill joint, holding joint rigidly in position during soldering and until solder has hardened. While joint is hot, remove excess solder and flux with cloth or brush. Take care to prevent annealing of copper tubing when making connections.
- E. Flanged Joints: Bolt flanges in accordance with ASA B16.2 or B15.5.

3.9 TESTS:

- A. Hydrostatic and Operational Tests:
  - 1. Hydrostatic testing will be required on all new piping.
  - 2. Test all lines hydrostatically before insulation is applied. Piping systems and joints shall be proven tight at 150 psi or 1-1/2 times operating pressure (whichever is higher) for a minimum of 4 hours. Repeat tests until proven tight.
  - 3. Prior to acceptance of completed piping installation, contractor shall subject system to such tests as may be required by Architect/Engineer to demonstrate satisfactory functional and operational efficiency. These tests shall cover a period of not less than 6 hours for each complete piping system tested. Conduct tests at such times as Architect/Engineer may direct. Calibrated instruments, Test Engineer, equipment, facilities and labor required to properly conduct tests shall be provided by Contractor at no additional cost. Repeat tests without cost, if failures occur.
  - 4. Submit written certification of date and time of acceptance of testing procedures to the Architect/Engineer.

3.10 CLEANING PIPING SYSTEMS:

- A. Refer to Section 15545 Chemical Treatment for additional pipe cleaning requirements.  
Contractor is responsible for introducing chemicals to be provided by chemical treatment

vendor, circulating chemicals, draining, flushing and refilling.

- B. After piping systems have been tested and proven tight, clean piping systems of dirt, scale, oil, grease, waste and other foreign substances which may have accumulated during process of installation. Strainer screens shall be removed, cleaned and replaced after cleaning flushing process is completed. Cleaning shall be complete prior to balancing.
- C. Water Systems: Clean and flush system with a compound procured from chemical treatment vendor. Refer to Section 15545.

After each system has been thoroughly and satisfactorily cleaned all low points "blown-down", interiors of strainers reinstalled, all temporary by-passes removed, systems filled with clean water, chemical treatment added and control valves adjusted, all systems shall be permanently connected.

- D. Provide Owner 48 hour advance notice prior to any pipe cleaning, provide written certification that cleaning has occurred and statement that strainer screens have been cleaned prior to system activation.

END OF SECTION

## SECTION 15120

### UTILITY PLANT PIPING SPECIALTIES

#### PART 1 GENERAL

##### 1.1 SUMMARY:

###### A. Section Includes:

1. Temperature indicators and wells
2. Pressure indicators and points
3. Combination temperature - pressure points
4. Expansion tanks
5. Hydronic air control
6. Relief valves
7. Combination air/dirt separators
8. Strainers
9. Side stream industrial water filters
10. Side stream flow eductors
11. Pressure reducing valves
12. Glycol fill system
13. Sulfuric acid double containment tank
14. Slide gates
15. Refrigerant Monitor

###### B. Related Sections:

1. Section 15010: Basic Mechanical Requirements
2. Section 15060: Pipe, Fittings and Valves
3. Section 15250: Mechanical Systems Insulation
4. Section 15950: Controls and Instrumentation

##### 1.2 SYSTEM DESCRIPTION:

###### A. The work includes but is not limited to the following:

1. Chilled water piping systems specialties required.
2. Condenser water and cooling tower piping system specialties required.
3. Heating water system specialties required.
4. Piping system specialties as required.

##### 1.3 SUBMITTALS:

###### A. Submit Shop Drawings and Product Data in accordance with Section 01300 - Submittals and Shop Drawings and Submittals paragraph in Section 15010 - Basic Mechanical Requirements for the following items:

1. Schedule of expansion joints showing type, location, size, and range.
2. Schedule of temperature indicators showing location, service, dial range, well insertion length, and well extension length.
3. Schedule of pressure indicators showing location, service, dial range, and stem length.
4. Schedule of pressure relief valves showing size and set pressure.



5. Shop drawings, cut sheets, and descriptive material for all products showing dimensions, range of use, and recommended applications.
6. Provide written certification that strainer screens have been inspected and cleaned following circulation and flushing procedure.

## PART 2 PRODUCTS

### 2.1 TEMPERATURE INDICATORS & WELLS: (TI)

- A. Temperature Indicators: Bi-metal dial thermometers, 1% accuracy, 5 inch dial white face, black figures, hermetically sealed with zero adjustment, friction pointer, stainless steel ring, case and stem. Back connection, adjustable angle, Trerice B8560, Ashcroft or approved equal. Each temperature indicator shall be supplied with a 304 stainless steel built-up well as specified below, with 3/4 NPT pipe connection. Coordinate required stem lengths.
- B. Temperature Wells: Shall be furnished and coordinated by the temperature indicator manufacturer. Wells for CPAS points shall be provided by Contractor in coordination with CPAS requests. Wells shall be constructed of 304 stainless steel to the proper depth, with 3/4 NPT pipe connection, and extension neck for insulated lines. Wells shall be furnished with screw plug attached to wells with chain to keep dirt out when not in use. 3/4 inch threadolets shall be welded to the pipe to receive wells. Direct welding of wells in the pipeline will not be permitted. Adequate clearance shall be provided adjacent the wells to allow for thermometer insertion in proper position. Provide fixed flange for duct mounted indicators.

### 2.2 PRESSURE INDICATORS AND POINTS: (PI)

- A. Pressure Indicators: 4-1/2" dial, cast aluminum case, dial range approximately 200 percent normal system pressure provided not less than 150 percent maximum system pressure, phosphor bronze bourdon tube, Trerice 500X, Ashcroft, or approved equal. Stop valves and snubbers shall be provided for each pressure indicator, installed between the service line and gauge. Provide friction pointer on all gauges.
- B. Pressure Points: Shall be constructed of 1/4 inch threadolets welded to the pipe, extension nipple, stop valve snubber, connection nipple and cap. Direct welding of extension nipple to the pipeline will not be permitted. Adequate clearance shall be provided above the pressure point to allow for proper gauge insertion.
- C. Quick Connect Fitting: Provide quick connect pressure gage fittings as detailed on drawings.

### 2.3 COMBINATION TEMPERATURE - PRESSURE POINTS: (PTP)

- A. Provide Model 700 1/2" NPT, neoprene core Pete's Plugs where indicate on drawings.
- B. Furnish Owner with two (2) temperature indicators and one (1) pressure gauge, suitable for insertion into Pete's Plugs.

### 2.4 EXPANSION TANKS:

- A. Air Control Tank Fitting: Shall be installed in expansion tank to facilitate air transfer from air separator into tank while restricting gravity circulation and tank temperature. Fitting shall include an integral or separate vent tube to establish an initial water level in tank and charging.
- B. Tank Drainer-Air Charger: Shall incorporate a vent tube and drain valve with hose connection for installation in bottom of expansion tank to facilitate draining tank.

- C. Expansion Tanks: Shall be black steel, rust proof coated on inside and out. Designed for 125 psig working pressure conforming with ASME Code for Unfired Pressure Vessels, stamped accordingly. Provide openings and install a gauge glass set, air control tank fitting, vent tube and drain valve. Gauge glass shall be fitted with protective guard and two angle valves. Precharge tanks as indicated on drawings.

2.5 HYDRONIC AIR CONTROL SYSTEM:

- A. Air Vents: Shall be provided at each high point in hydronic system and shall have 3/4 inch copper tubing discharge line from vent to nearest drain pan, floor drain, drain line, or where directed.
  - 1. Automatic Air Vents: Shall be brass with built-in air chamber, sealed float with hardened valve pin, and threaded IPS connection. Air vents shall be constructed for a working pressure in excess of system operating pressure and be unaffected by temperatures up to 225 degrees F. Provide 3/4 inch ball valve between system and vent. Use Armstrong AAWE-750 or equal.
  - 2. Manual Air Vents: Shall be provided where indicated on the drawings and shall incorporate a 3/4 inch brass ball valve and plug.
- B. All components of the hydronic air control system shall be furnished by a single manufacturer, Bell & Gossett, Armstrong, Taco or approved equal.

2.6 COMBINATION AIR AND DIRT SEPARATOR (Chilled water and Glycol/ water):

- A. Provide combination air and dirt separator as scheduled on drawings. Design to incorporate integral bundle of turbulence suppressive medium that fills entire volume of 150 psig pressure vessel. Provide flanged connectors select unit at less than 1 psig pressure drop.
- B. Unit to include integral float actuated brass air vent, valved side tap for quick bleeding, and extended bottom for dirt separation. Unit shall have removable lower head with manual blowdown valve.
- C. Spirotherm air/dirt separator, inlet size as indicated on drawings.

2.7 INDUSTRIAL SIDE STEAM SAND FILTER PACKAGE:

The filter system shall be a vertical tank type with a flow rate and surface area as scheduled in drawings. Vessel shall be equipped with four butterfly valves and linked together with common linkage rod. Valves shall rotate to change position with single lever or air operated actuator for backwashing. Unit will have all necessary gauges, air relief and drain lines. Unit to be tested and fully assembled by original equipment manufacturer prior to shipping.

- A. Capacity: The filters shall remove 90% by volume of the suspended particles larger than 5 microns.
- B. Filter Tank: The tank shall be constructed of carbon steel and shall be suitable for a working pressure of 50 psi. The tank shall be epoxy lined on the interior and painted on the exterior. Inlet and outlet connections shall be flanged Sch 40 steel pipe located in the tank side. The internal underdrain assembly shall be constructed with removal laterals. Each unit shall be equipped with a manhole located at the top of the unit, and a hand hole for clean-out on the tank side. A pressure gauge and air relief assembly shall also be provided.
- C. Holding Tank: Provide holding tank identical in construction to filter tank and with sufficient volume to accept entire backwash volume for one cycle. Provide 3" drain and 2" vent or holding tank.

- D. Valves: Four positive sealing butterfly valves with mechanical linkage shall be provided.
- E. Filter Media: Filter support media shall be screened garnet for removal of solids 5 microns and larger.
- F. Automatic Operation: The filter shall be furnished with an automatic backwash system to clean the filter media when the differential pressure across the tank increases to a pre-set point. The automatic backwash system shall include: a pressure switch, pneumatic valve, valve actuator, and solenoid valve, NEMA 3R control panel containing a service transformer, a backwash timer and a pushbutton for manual backwash override. Provide ability to control remote pump operation. Provide contact closure sufficient to pass pump status, and backwash status to CPAS.
- G. PEP Model BMF or approved equal.

2.8 STRAINERS:

- A. Y-strainers flanged body, iron, 175 psig working pressure 1/8 inch stainless steel perforated screen. Hayward Model 85/80 or approved equal.
- B. Tee strainers, iron 175 psig working pressure 1/8" stainless steel perforated screen, weld end, hinged lid, Hayward model 91 or approved equal.

2.9 SIDE STREAM FLOW EDUCTORS:

- A. Provide eductors of type and size as shown on drawings.
- B. Jet shall be designed and oriented so as to convey debris from basin to the filtration system.
- C. PEP model PSJ or equal polypropylene reinforced or approved equal.

2.10 PRESSURE REDUCING VALVE:

Pressure Reducing Valve (Water): Shall be diaphragm operated, spring loaded type with a separate, easily cleanable, in-line strainer and a separate in-line check valve or may be type that has built-in strainer of the easily removable type without system shutdown and an anti-siphon check valve.

- A. Operation: Shall be designed for 125 psi maximum working pressure and shall withstand a 225 degrees F minimum operating temperature and shall have a minimum adjustable range of 8 psi above and below set point.
- B. Materials: Body of valve shall be bronze, brass or iron. Working parts of valve shall be bronze, brass or stainless steel.

2.11 GLYCOL-WATER SYSTEM:

- A. Propylene glycol shall be inhibited with 1.75 percent dipotassium phosphate.
- B. Provide required amount of glycol to obtain the percent by volume for glycol-water systems as follows and to provide two tank reserve supply: 50 percent.
- C. Glycol-Water Make-up System:
  1. Glycol-Water storage tank: Self supporting or polyethylene, minimum 90 mil thickness, with removable cover or black steel with 90 mil polyethylene insert. Capacity shall be 55

gallons, with approximate diameter of 23 inches and height of 36 inches. Reinforced threaded pipe connections shall be provided for all connections. Provide identification for tank showing name of the contents.

2. Glycol-Water make-up pump: Bronze fitted, self-priming, high head type suitable for pumping a 33 percent to 50 percent glycol-water solution in intermittent service. The pump shall be provided with a mechanical shaft seal and be flange connected to a 1750 rpm NEMA type C motor. The pump capacity shall be three gpm 50 psig discharge pressure with a suction lift capability of five inches of mercury with a 1/3 horsepower drip-proof motor. The pump may be a "gear-within-a-gear" positive displacement type with built-in relief valve set for 43 psig, or the pump may be a regenerative turbine type providing self-priming with built-in or external relief valve set for designhead of the pump.
3. Back pressure regulating valve: Spring loaded, diaphragm actuated type with bronze or steel body, stainless steel trim with capacity to relieve 100 percent of pump flow with an allowable rise in the regulated pressure of 10 psi above the set point. Set point shall be 15 psi above system PRV setting.
4. Low water level control: Steel or cast iron float housing, stainless steel float, positive snap-acting SPST switch mechanism, rated 10 amps – 120 volt AC, in General Purpose (NEMA 1) enclosure. The control shall be rated for pressures to 150 psig and make alarm circuit on low water level. The alarm circuit shall be wired to the Chiller Plant Automation System.

#### 2.12 SULFURIC ACID DOUBLE CONTAINMENT TANK:

- A. Provide double wall tank-in-tank of size and dimensions shown on drawings that complies with 40CFR-264.193.
- B. Tank materials and construction shall be design for outdoor use (UV stabilized) and prevent rain, snow and debris from entering outer containment vessel.
- C. Tank shall be designed for long term storage of 95% sulfuric acid.
- D. Provide tie down restraints suitable for seismic zone 4 and UBC 110 mph wind loading conditions.
- E. Outer tank shall have 115% capacity of inner tank.
- F. Provide overflow protection, manway leak detection system, gallonage indicator, OSHA approved ladder system, fill pipe assembly, drain assembly.
- G. Ryan Herco model 7412 XLPE or approved equal.

#### 2.13 SLIDEGATES:

- A. General: The gates shall be downward opening, self-contained with yoke and bench stand operators.
- B. Frame and Guides: The gate frame shall be a rigid unit composed of stainless steel guide rails with UHMW seats upstream and downstream. These shall form a tight seal between the frame and the slide (disc). This tight seal shall provide an allowable leakage rate of no more than .1 gallons per minute (GPM) per peripheral foot of perimeter opening for seating heads and .2 GPM per peripheral foot for unseating heads. Stainless steel retainer bars, cross bars and head rails (for self-contained gate only) shall be provided. The clear opening shall be the same size as the waterway, unless otherwise specified. The guides will be of sufficient length to support two-thirds of the height of the slide when in the full open position.

- C. Slide Cover (Disc): The slide cover (disc) shall be stainless steel plate reinforced with structural shapes welded to the plat. The slide cover shall not deflect more than 1/720<sup>th</sup> of the span of gate under the maximum head. The stem connection shall be either the clevis type, with structural members welded to the slide and a bolt to act as a pivot pin, or a threaded and bolted (or keyed) thrust nut supported in a welded nut pocket. The clevis or pocket and yoke of the gate shall be capable of taking, without damage, at least twice the rated thrust output of the operator at 40 pounds pull.

The fabricated gates shall be Waterman SS-250 Series.

- D. Materials:

Frames, Rails, Cover Slides, Yokes  
Stainless Steel – ASTM A276, Type 316CW

Fasteners and Anchor Bolts  
Stainless Steel – ASTM A-593 and 594, Type 316CW.

Stems  
Stainless Steel – ASTM A-276, 316

Seats  
Ultra High Molecular Weight Polyethylene (UHMW)

Finish  
Mill finish on all stainless steel surfaces

#### 2.14 REFRIGERANT MONITORS (2):

- A. Monitor shall employ wideband photoacoustic Infrared (IR) sensor technology, for sensing down to thirty parts per million (ppm), and calibrated for specific refrigerant (Specify Refrigerant). Monitor shall continuously measure and display the specified gas concentration. Shall be capable of detecting presence of refrigerant R-123. System shall be capable of indicating, alarming, shutting down equipment, and automation/ventilation interface.
- B. Monitor System Configuration – System shall conform to the design specifications as follows.
1. Description – Monitor shall activate an alarm an mechanical equipment room ventilation at less than the TLV-TWA. Sample pick-up shall be located in an area where refrigerant from a leak will concentrate (ASHRAE-15 1994).
  2. The monitor shall be wall mount type for continuous monitoring.
    - a. Enclosure – The enclosure shall be NEMA 250 design type.
    - b. Enclosure shall be no more than 14 inches in any dimension.
    - c. Mounting Points shall be integral to enclosure.
    - d. All displays shall be visible from front panel. Displayed information shall include Refrigerant Type and Concentration, sample location, and self diagnostic condition reports (faults). LED's shall indicate Power, Ready, Alarm 1, Alarm 2, Alarm 3, and any fault condition. All LED's shall have a corresponding NO/NC relay so that the same information can be remotely displayed.
    - e. Monitor shall be able to transmit gas concentration and self-diagnostic information

up to 1000 ft.

- f. Coverage shall be expandable with Eight (8) Channel Scanner.
- g. Monitor shall employ an internal pump to draw samples up to 300 ft.
- h. Accuracy – The display accuracy shall be +/- 1 ppm in the 0-100 ppm range and +/- 10% of reading or better for values over 100 ppm.
- i. Operating Temperature - 40°F to 120°F non-condensing.

3. Monitor Design Requirements:

- a. Display – A2 line LCD shall be provided for display of sensor location, gas type and concentration, alarm type, malfunction diagnostics and set-up information. Self-diagnostics to include IR source check, sample pump check, chopper function check, temperature and electrical continuity. All error codes are to be plain language, malfunction codes are not permitted.
- b. Alarm Set Points – Three (3) levels of alarm shall be provided for High, Low, and Off Scale conditions. Alarm set points shall be independently adjustable. At least two (2) alarm levels shall be user adjustable at values less than full scale. Relays shall be user selectable Latching or Non-latching.

A third, non-user adjustable alarm shall be provided at greater than the full scale value. This (Offscale) Alarm shall be capable of initiating combustion process shutdown and used to provide remote notification to prevent persons from entering a highly contaminated space without breathing protection.

- c. Visual Alarm Indication – LED's shall energize for each level of alarm, fault or malfunction. Additional LED's shall indicate that unit is receiving power and ready for operation.
- d. Relay Outputs – Each alarm set points shall activate a discrete relay. Four (4) dry contacts shall be provided to initiate output signal for three (3) level alarms and malfunction at local panel, interface with both the DDC or BMS and the machine room ventilation system. Contact ratings shall be rated 7 amps at 120 VAC, SPDT, Form C.
- e. Audible Alarm – An audible alarm (90dB) shall energize when alarm condition or fault condition occurs. Audible alarm shall pulse at variable frequency to indicate type of alarm.
- f. Visual Indication – An amber strobe light alarm shall energize when high or offscale alarm or fault condition occurs.

4. Power Requirements – System shall operate on 115 – 230 VAC, 50 Hz/60Hz.

- C. Maintenance – System shall require no periodic adjustments other than checking against a clean air source every 6 months. Span calibration frequency shall be no more than once every 12 months. Changes in External Zero Filters and Line Filters are unacceptable. Internal Sample Filters should be visually checked every 6 to 12 months and replaced if needed.
- D. Halogaurd III or prior approved equal.

PART 3 EXECUTION

3.1 INSTALLATION:

- A. Coordinate installation details including mounting and anchoring to base with concrete work
- B. Install equipment in strict accordance with manufacturer's recommendations.

3.2 START UP AND COMMISSIONING:

- A. Provide Start-Up and Commissioning Services for all equipment, including:

- 1. Air/Dirt Separators
- 2. Industrial Water Filtration System
- 3. Glycol Fill System
- 4. Hydronic Air Control System
- 5. Refrigerant Monitor
- 6. Sulfuric Acid System

- B. Commissioning Services shall include:

- 1. Completion of Pre-functional Checklists as developed by Commissioning Agent.
- 2. Participation in Functional Performance testing including:
  - a. Flow and Pressure Testing
  - b. Speed Control and VFD Testing
  - c. Automatic Valve Testing
  - d. Safety Interlock Testing
  - e. Plant Sequence and Control Testing
- 3. Take corrective actions necessary to resolve deficiencies uncovered in the commissioning process. Work to be completed within schedule established by the Commissioning Agent.
- 4. Provide complete supporting documentation, including:
  - a. Submittal and engineering data.
  - b. Operation and maintenance data.
  - c. Spare parts data.
  - d. As-Built installation drawings

3.3 WARRANTY:

- A. Warranty shall cover labor, parts, and materials for all equipment for two years of date of acceptance.

3.4 CLEANING AND PAINTING:

- A. All exterior and interior metal surfaces shall be thoroughly cleaned of all sand, mill scale, grease, oil, dirt, and other foreign materials.
- B. The exterior surfaces of all carbon steel material shall be painted in accordance with the requirements of Section 15010: Basic Mechanical Requirements.

3.5 CLEANING OF STRAINERS:

Contractor shall remove, inspect and clean all strainer screens following pipe cleaning and flushing. Provide Certificate of Compliance.

END OF SECTION



SECTION 15160  
PUMPS AND PUMP MOTORS

PART 1 GENERAL

1.1 SUMMARY:

A. Section Includes:

1. Double suction horizontal split case pump
2. In-line mounted centrifugal pump
3. Vertical turbine pump
4. Self Priming pumps

B. Related Sections:

1. Section 01650: Starting of Systems
2. Section 15240: Mechanical Sound and Vibration Control
3. Section 16925: Variable Frequency Drives

1.2 QUALITY ASSURANCE:

- A. Manufacturer: Company specializing in manufacture, assembly, and field performance of pumps with minimum ten years experience with local stocking of parts and authorized service in Albuquerque area.
- B. Performance: Manufacturer shall warrant performance of pumps when operating under the specified or indicated conditions. Repair or replace pumps which are found deficient in field testing.

1.3 SUBMITTALS:

- A. Submit Shop Drawings and Product Data under provisions of Section 01300 Submittals. Submittal shall include complete dimensional prints.
- B. Submit certified pump curves showing performance characteristics with pump and system operating point plotted and test data results. Submit complete pump curves showing operation throughout range of variable speeds.
- C. Submit motor efficiency and power factor data for one-half, three quarters, and full load conditions.
- D. Submit manufacturer maximum vibration tolerances data expressed as 3 axis acceleration.
- E. Submit written statement of pump delivery from date of approved shop drawings.
- F. Submit alignment certification and baseline vibration results

1.4 WARRANTY:

- A. The pump unit supplier shall provide complete warranty coverage for every component provided, without exception for a period of twenty-four months from the date of final acceptance by the Owner/Engineer. As part of the warranty, the pump unit supplier shall provide written confirmation to the Owner/Engineer that each unit has been installed in a manner acceptable for the warranty to proceed.

1.5 SCHEDULE:

- A. Equipment supplier shall commit to delivery of equipment.

PART 2 PRODUCTS

2.1 DOUBLE SUCTION SPLIT CASE PUMPS:

- A. Acceptable Manufacturers:

1. Bell and Gossett
2. Allis Chalmers
3. Goulds

- B. General:

1. Furnish and install, as outlined on the equipment schedule and described in these specifications, double suction horizontal split case centrifugal pumps designed to deliver the scheduled flow rate at the specified total dynamic head (in feet). All pumps will have variable frequency drives and a full size impeller.

- C. Casing:

1. Pumps shall have the casing divided on the horizontal center line. The casing halves shall be accurately machined, bolted and doweled together. A non-asbestos type gasket material shall be furnished between the casing halves. The casing material shall be close-grained cast iron with a minimum tensile strength of 35,000 P.S.I. Removal of the upper casing half and bearing housings shall permit removal of the complete rotating assembly without disturbing piping connections. Removal of the bearing housing shall permit inspection of the mechanical seals, the shaft sleeves and bearings without removing the rotating assembly or top casing half.
2. Casings shall be designed for scheduled working pressure and shall be hydrostatically tested. Suction and discharge flanges shall be drilled to ANSI Standards and be machined flat face. Pumps shall be fitted with bronze renewable case wear rings indexed with a dowel pin for fixed positioning.

- D. Impeller:

1. The impeller shall be an enclosed type double suction design, hydraulically and dynamically balanced. The impeller is to be securely mounted on the pump shaft, and attached with a stainless steel impeller key. The impeller shall be locked in position by threaded sleeves.

- E. Bearings:

1. The pump shaft shall be adequately supported by the pump bearings to limit the shaft deflection to .002 inches.
2. Bearings shall be the ball type, grease lubricated and locked to the shaft with positive locks of ample size to withstand any axial thrust loads.
3. Each bearing housing shall be bolted to the upper and lower casing halves for a full 360 degree support registered fit to insure positive alignment.

- F. Shaft Seal:

1. The pump manufacturer shall recommend the proper mechanical seal based on the pressure, temperature and liquid outlined on the equipment schedule.

G. ShaftSleeves:

1. Bronze shaft sleeves shall be firmly attached to the pump shaft through threading and locking means. Shaft sleeve design shall prevent corrosion and wear to the shaft.

H. Base, Coupling and Guard:

1. The pumps shall be mounted on a steel base and directly connected through a heavy duty flexible coupling to a horizontal motor as outlined in these specifications. The pump manufacturer shall provide an OSHA coupling guard which shall be mounted between the pump and motor and attached firmly to the base.

I. Motors:

1. The motor shall be sized to operate continuously without exceeding the horsepower rating as outlined on the schedule regardless of the flow and head throughout the entire range of operation.
2. Motor shall be in accordance with Paragraph 2.04, Section 15160.

2.2 IN-LINE MOUNTED CENTRIFUGAL PUMP:

A. Acceptable Manufacturers:

1. Bell and Gossett Series 80.
2. Armstrong Pump Series 4380.
3. Prior approved equal.

B. General:

1. Furnish and install pump with capacity as shown on Drawings. Pump shall be in-line type, close-coupled, single-stage design, for installation in vertical position, and capable of being serviced without disturbing piping connections. Pump should not be supported at that the casing but rather hung from adjacent pipe. If the pump must be supported from the casing, a vibration isolation mount must be used

C. Casing:

1. Pump casing shall be of Class 30 cast iron. The impeller shall be of cast bronze, enclosed type, dynamically balanced, keyed to the shaft and secured by a locking capscrew.

D. Liquid Cavity:

1. The liquid cavity shall be sealed off at the motor shaft by an internally-flushed mechanical seal with ceramic seal seat and carbon seal ring, suitable for continuous operation at 225 deg. F. A bronze shaft sleeve shall completely cover the wetted area under the seal.

E. Rating:

1. Pump shall be rated for minimum of 175 psi working pressure. The pump case shall have

gauge tapings at the suction and discharge nozzles and shall include vent and drain ports.

F. Motor:

1. Motor shall be in accordance with Paragraph 2.04, Section 15160 and shall be the size, voltage and enclosure called for on the Drawings. It shall have heavy-duty grease lubricated ball bearings, completely adequate for the maximum load for which the pump is designed.

G. Testing:

1. Each pump shall be factory tested. It shall then be thoroughly cleaned and painted with at least one coat of high-grade machinery enamel prior to shipment.

2.3 VERTICAL TURBINE PUMPS:

A. Acceptable Manufacturers:

1. Goulds
2. Peerless
3. Bell and Gossett.

B. General:

1. Furnish and install, as outlined on the equipment schedule and described in these specifications, vertical turbine pump designed to deliver the scheduled flow rate at the specified total dynamic head (in feet).

C. Motor:

1. The motor thrust bearings shall have ample capacity to carry the weight of all the rotating parts plus the hydraulic thrust of the pump impellers. The motor shall be of the full voltage starting, vertical hollow shaft, squirrel cage induction type and shall conform to the standards of the National Electrical Manufacturers Association.
2. Refer to 2.04 for additional motor requirements.

D. Pump Head:

1. A pump head of high grade cast iron or fabricated steel shall be provided for mounting the motor, with an above-ground flanged discharge outlet and a companion flange 18 inch standard pipe.

E. Pump Column Assembly:

1. The total length of the discharge column shall be as required to meet minimum bottom clearance requirements. The column pipe shall be not less than 14 inches inside diameter. The pipe shall be connected with threaded, sleeve type couplings. The joints are to be butted to insure perfect alignment after assembly.
2. The line shaft shall be turned, ground and polished precision shafting of ample size to operate the pump without distortion or vibration. The column shall be furnished in interchangeable section not over ten feet in length and shall be coupled with strong steel couplings machined from solid bar steel. The stainless steel journal O.D. will be

substantially flush with the shaft O.D. (Recess not to be deeper than diameter corresponding to the root diameter of shaft threads.)

3. The column assembly shall have bronze bearing retainers threaded into the pipe couplings and retained by the butted pipe ends. Each bearing retainer shall contain a water lubricated cutless rubber bearing designed for vertical turbine pump service.

F. Pump Bowl Assembly:

1. The pump bowl shall be of close grained cast iron having a minimum tensile strength of 30,000 pounds per square inch, free from blow holes, sand holes, and all other faults; accurately machined and fitted to close dimensional tolerances.
2. The impeller shaft shall be of stainless steel of not less than 12% chrome. The impeller shaft shall be supported by a combination of water lubricated fluted rubber and bronze bearings.
3. Impeller shall be of cast iron, accurately machined and finished, and mechanically balanced. They shall be securely fastened to the impeller shaft with a tapered bushing.
4. Each bowl shall have an impeller seal ring to prevent slippage of water between bowl and impeller. The impellers shall be adjustable by means of a top shaft nut at the top of the motor.

G. Suction Strainer:

1. Suction Strainer shall be 316 stainless steel, bowl mounted.

H. Provide sole plate, stuffing box, and coupling.

2.4 SELF PRIMING CENTRIFUGAL PUMPS:

- A. Pump shall be open type capable of handling solids up to 3 inches in diameter.
- B. Gray iron casing with ductile iron impeller.
- C. Provide pressure relief valve, automatic air release valve and suction and discharge spool flanges. Base mount on frame with motor and coupling.
- D. Gormann-RUPP Model T6A3.

2.5 PUMP MOTORS:

- A. Standards: All electric motors shall be inverter duty induction type, conforming to latest requirements of NEMA, UL, and NEC. All materials and equipment shall be in accordance with the applicable requirements of the Federal Occupational Safety and Health Standards.
- B. Ambient Conditions: Motors shall be sized to operate at 5000 ft elevation at an ambient temperature of 40°C unless otherwise indicated.
- C. Motor Design Requirements: Motors shall be designed for full voltage starting and frequent starting conditions. Motors shall be designed for use with variable frequency drive as specified in Division 16. Manufacturer shall certify that motors are approved for use with approved variable frequency drives per Division 16. The torque characteristics of all induction motors at any voltage from 90 percent rated voltage to 110 percent rated voltage shall be as required to accelerate the inertia loads of the motor and driven equipment to full speed without damage to the motor or the equipment. All motors shall have a service factor of 1.15 in accordance with

NEMA MG 1-12.47.

D. Motor Construction:

1. Enclosure: All motors shall be self-ventilated. All self-ventilated open type motors, including those with dripproof, splashproof, and weather-protected enclosures, and the fan covers of totally enclosed fan-cooled motors shall meet NEMA MG 1 requirements for a fully guarded machine.
  - a. Totally enclosed motors shall be furnished with drain holes and rotating shaft seals. Frames, bearing brackets, external terminal housings, and fan covers for fan-cooled motors shall be cast iron. External cooling fans for fan-cooled motors shall be fabricated of brass, bronze, aluminum alloy containing not more than 0.2 percent copper, malleable iron or plastic. All plastic fans shall be fabricated of a reinforced thermosetting plastic and shall be U.L. approved.
  - b. Outdoor motors shall have NEMA waterproof enclosures. All exposed metal surfaces shall be protected, where practical, with a corrosion-resistant polyester paint or coating. Exposed unpainted and uncoated surfaces shall be of a corrosion-resistant metal. Enclosure exterior and interior surfaces, air gap surfaces, and windings shall be protected with a corrosion-resistant alkyd enamel, polyester, epoxy paint, or coating.

Enclosure parts for all motors (e.g., frames, bearing brackets, terminal housing) shall be made of cast iron, cast steel, sheet steel, or steel plates.

2. Terminal Housings:

- a. Externally mounted terminal housings shall be in accordance with NEMA MG 1. The terminal housings shall be diagonally split for easy access to the motor leads, and designed for rotation in 90 degree increments. A gasket shall be furnished between the halves of the housing. Motor leads shall be completely wired into the externally mounted terminal housing.
- b. Motors furnished in NEMA 320 frame series and larger shall have terminal housings designed and constructed to permit motor removal after installation without disconnecting raceways from the terminal housings.
- c. Motor power leads and space heater leads shall be wired into the motor terminal housing. All motor leads and their terminals shall be permanently marked in accordance with the requirements of NEMA MG 1, Part 2. Each lead marking shall be visible after taping of the terminals.
- d. All motors rated 100 horsepower and larger, all motors furnished with unidirectional blowers, and all vertical motors shall have the direction of rotation marked by an arrow mounted visibly on the stator frame near the terminal housing or on the nameplate and the leads marked for phase sequence T1, T2, T3 to correspond to the direction of rotation and supply voltage sequence.
- e. Cable type leads shall be provided with Burndy type YA or acceptable equal compression type connectors.
- f. All motors, including those with resilient mountings, shall be furnished with a ground connection in accordance with NEMA MG 2-2.09.

3. Insulation and Windings:

- a. All winding conductors shall be copper. Insulation shall be Class F with a Class B temperature rise.
  - b. Motors shall be designed to keep torsional and rotational natural frequencies of vibration at least 25 percent above the motor rated speed ranges to avoid resonant vibration over the operating speed range of the driven equipment motor unit.
  - c. For motors greater than 75 hp a temperature sensor (thermistor type) shall be on stator windings, one per phase. Sensors will be tied to VFD shutdown inputs.
4. Shaft and Bearings:
- a. The output shafts of motors 100 horsepower and larger furnished with sleeve bearings shall be circumscribed with permanent marks indicating the motor magnetic center and end float limits when level and running at rated speed. A permanent, identified reference point shall be indicated or attached to the bearing housing or shaft seal. The markings shall be easily identifiable for use during motor installation.
  - b. For horizontal sleeve bearing motors, the rotor end float and coupling end play shall be in accordance with NEMA MG 1-14.37. The minimum rotor end float in fractions of an inch and the maximum diameter in inches of the lathe center in the shaft extension shall be indicated on the motor dimensional outline drawings.
  - c. Shafts shall be furnished with corrosion-resistant treatment or shall be of a corrosion-resistant material.
  - d. Motors rated 200 horsepower and less shall have torques and locked-rotor current in accordance with NEMA MG-1, Part 12.
  - e. All motors shall be completely assembled with the driven equipment, lubricated, and ready for operation.
  - f. All bearings, both connected-end and idler, shall be insulated. All bearings shall be self-lubricating, shall have provisions for relubrication, and shall be designed to operate in any position or at any angle. One-piece sleeve bearings with wick lubrication shall be furnished where available. Double-shielded grease lubricated ball bearings shall be furnished on fractional horsepower motors where sleeve bearings are not available or where axial thrust load exceeds 20 pounds. Unshielded grease lubricated ball bearings shall be furnished on integral horsepower motors where sleeve bearings are not available or where axial thrust load exceeds 20 pounds.
  - g. All bearing mountings shall be designed to prevent the entrance of lubricant into the motor enclosure or dirt into the bearings, and when required, shall be fitted with pipes, drain plugs, and fittings arranged for safe, easy relubrication from the outside of the motor while the motor is in service.
  - h. All induction motors shall have squirrel-cage rotors adequately sized to avoid overheating during acceleration of the motor and driven equipment. Rotors shall be dynamically balanced.
  - i. Each motor shaft shall be equipped with a shaft grounding device. The contract brushes shall be brass or stainless steel. The grounding device shall be approved by the motor manufacturer, and no field modifications to fit the device to the shaft shall be required.

5. Efficiency: All motors over 1 HP shall be premium efficiency. Efficiency rating shall be in accordance with IEEE Standard 112-1984 Method B. Motor nameplate shall be stamped in accordance with NEMA MG 1-12.542 as "NEMA nominal efficiency".

### PART 3 EXECUTION

#### 3.1 INSTALLATION:

- A. Coordinate installation details including mounting and anchoring to base with concrete work
- B. Install pumps in strict accordance with manufacturer's recommendations.
- C. Base mounted pumps and motors shall be realigned by the Contractor according to the standards of the Hydraulic Institute after grouting of base and connection of piping.
- D. Submit pump alignment certification.

#### 3.2 START UP AND COMMISSIONING:

- A. Provide Start-Up and Commissioning Services for all pumps and pump motors, including:
  1. Chilled Water Pumps (Double Suction)
  2. Side Stream Chilled Water Pumps (In-Line)
  3. Glycol Heating Water Pumps (In-Line)
  4. Condenser Water Pumps (Vertical Turbine)
  5. Side Stream Filtration Pumps (Self Priming)
- B. Commissioning Services shall be in accordance with Section 15995 and 17100 and shall include:
  1. Completion of Pre-functional Checklists as developed by Commissioning Agent.
  2. Inspection of installation of all pumps with greater than 75 HP motor by Manufacturer's Authorized Representative, and submittal of statement certifying that all pumps have been field aligned in accordance with the standards of the Hydraulic Institute.
  3. Submission of results of 3 axis vibration baseline test on all pumps with greater than 75 HP motor.
  4. Participation in Functional Performance testing including:
    - a. Pump Flow and Pressure Testing
    - b. Pump and Motor Vibration and Thermographic Testing
    - c. Speed Control and VFD Testing
    - d. Automatic Valve Testing
    - e. Safety Interlock Testing
    - f. Plant Sequence and Control Testing
  5. Take corrective actions necessary to resolve deficiencies uncovered in the commissioning process. Work to be completed within schedule established by the Commissioning Agent.
  6. Provide complete supporting documentation, including:
    - a. Submittal and engineering data.
    - b. Operation and maintenance data.
    - c. Spare parts data.



d. As-Built installation drawings

Final documentation package to be as described in Section 15995 and 17100

3.3 WARRANTEE:

- A. Warrantee shall cover labor, parts, and materials for all equipment for two years of date of acceptance.

END OF SECTION

## SECTION 15250

### MECHANICAL SYSTEMS INSULATION

#### PART 1 GENERAL

##### 1.1 SUMMARY:

###### A. Section Includes:

1. Ductwork insulation
2. Insulation of Hot Pipe.
3. Insulation for Cold Pipe.
4. Insulation for Cold Equipment.
5. Inserts and Saddles.

###### B. Related Sections:

1. Section 01300 - Submittals.
2. Section 09900 - Painting.
3. Section 15010 - Basic Mechanical Requirements.
4. Section 15050 – Basic Mechanical Materials and Methods.
5. Section 15060 – Utility Plant Piping.
6. Section 15520 – Steam and Condensate Piping

##### 1.2 SYSTEM DESCRIPTION:

A. The mechanical insulation work required by this Section shall include materials and methods as described herein and on the Drawings and as required by applicable energy standards.

B. The work includes, but is not limited to, providing insulation on the following:

1. Insulation of supply and return air ductwork
2. Insulation of all chilled water piping systems.
3. Insulation of all steam and condensate systems.
4. Insulation of all Glycol Heating Systems.
5. Insulation of all water piping including side steam filtration and make up water.

##### 1.3 QUALITY ASSURANCE:

A. Qualifications: The firm executing the work of this Section shall have at least 3 years successful installation experience on projects with mechanical insulations similar in scope and nature to that required for this Project.

- B. Requirements of Regulatory Agencies: All insulation shall be in accordance with City, State, and Federal Energy Conservation Standards.

1.4 SUBMITTALS:

- A. Product Data: Submit manufacturer's specifications and installation instructions for each type of mechanical insulation in accordance with Section 01300 - Submittals. Include schedule showing manufacturer's product number, thickness and furnished accessories for each mechanical system requiring insulation.

1.5 PRODUCT DELIVERY, STORAGE AND HANDLING:

- A. Delivery of Materials: Deliver insulation, coverings, adhesives, and coatings to site in containers with manufacturer's stamp or label affixed showing fire hazard ratings of products.
- B. Storage of Materials: Protect insulation against dirt, water, chemical and mechanical damage. Do not install damaged insulation; remove from project site.
- C. Every package or standard container of insulation, jackets, facings, cements, adhesives and coatings delivered at the building site for use must have a manufacturer's stamp or label attached giving name of manufacturer, brand and description of material.

PART 2 PRODUCTS

2.1 MANUFACTURERS:

- A. Owens Corning Fiberglass, CSG, Armstrong, Knauf or Johns-Manville. All material must meet UL and NFPA 90A fire hazard classification requirements.

2.2 FIRE RESISTANCE:

- A. Insulation, adhesives, sealers, vapor-barrier coatings, vapor-barrier and cut lining materials shall be noncombustible as defined in Section 200 of National Building Code; shall have a flame-spread rating of not more than 25 and a smoke developed rating of not more than 50. Materials that are factory applied shall be tested as assembled and certified by manufacturer to meet standards. Materials which are field applied may be tested individually. No fugitive or corrosive treatments shall be employed to impart flame resistance. Insulation shall be asbestos free.

- B. Flame Spread and Smoke Developed Ratings shall be determined by Method of Test of Surface Burning Characteristic of Building Materials, NFPA No. 255, ASTM E84; Underwriters' Laboratories, Inc. Standard No. 723. Such materials are listed in Underwriters' Laboratories, Inc. Building Materials Listed under heading "Hazard Classification (Fire)."

2.3 VAPOR RESISTANCE:

- A. Vapor barrier shall be permanently resistant to flame and passage of moisture vapor and shall have the following physical properties:
  - B. Pipe jacketing and duct facings:
    - 1. Shall be Types I and II in accordance with Fed. Spec. HH-B-100.
    - 2. Jackets and facings on insulation for piping, ducts, and equipment in exposed areas shall have a white finish suitable for painting without sizing.
    - 3. Type I insulation jackets shall be used on all piping in exposed and concealed areas.
    - 4. Type I or II insulation facings shall be used on ducts and equipment in concealed areas.
    - 5. Perm rating shall be not more than .02, when tested in accordance with ASTM E96. Procedure A.
    - 6. Beach puncture shall be 50 units for Type I and 25 units for Type II, when tested in accordance with ASTM D781.
    - 7. Shall not support mold growth or mildew, when tested in accordance with ASTM D2020, Method A.

2.4 INSULATION FOR HOT PIPE:

- A. The following piping, fittings, flanges, and valves and accessories shall be insulated:
  - 1. Steam, condensate systems.
  - 2. Glycol heating water.
- B. Pipe insulation shall be molded fiberglass, with an All Service Jacket (ASJ). Fittings and valves shall be insulated with insulating cement, compressed blanket wrap, pipe insulation segments or molded fiberglass fitting covers to thickness of adjoining insulation. Finish blanket or pipe segments with skim coat of insulating cement. Cover insulation on pipe and fittings, etc. with fiberglass tape, 6 oz. canvas embedded in two coats of fire retardant mastic or plastic fitting covers.
- C. Thickness of insulation for water piping, fittings, flanges and valves shall be 1" on pipe 1/2" through 1", 2" for 1-1/4" pipe through 6" and 2" for 8" pipe and above. For steam and condensate return piping, insulation shall be 1" thick on pipe 1/2" through 1", 2" on 1 1/4" to 4", 3" for over 4".
- D. Provide aluminum jackets on all insulated pipe exposed to the weather. Jackets and fitting covers shall be neatly installed in a manner that does not compromise the integrity of the insulation vapor barrier.

2.5 INSULATION FOR COLD PIPE:

- A. The following piping, fittings, flanges, and valves shall be insulated:
  - 1. Chilled water (CHWS, CHWR).
  - 2. Domestic and building service water.
  - 3. Side stream sand filter piping outside cooling tower enclosure.
- B. Pipe insulation for water piping shall be molded fiberglass with an All Service Jacket (ASJ). Fitting and valves shall be insulated with insulating cement, compressed blanket wrap, pipe insulation segments, or molded fiberglass fitting covers to thickness of adjoining insulation. Finish blanket or pipe segments with skim coat of insulating cement. Cover insulation on exposed fittings, etc. with fiberglass tape, 6 oz. canvas embedded in two coats of fire retardant mastic, or plastic fitting covers. The complete system shall provide a continuous vapor barrier.
- C. Insulation at pipe supports shall be 3/8" armorflex as indicated in Details.
- D. Insulation Thickness: Piping, fittings, flanges and valves for chilled water shall be insulated with 1/2" thick on all pipes 1/2" through 1", 1" thick on all pipes 1-1/4" to 4", 1-1/2" thick for all pipes 6" through 24" and 2" thick for all pipe larger than 24".
- E. Provide aluminum jackets on all exposed pipe. Jackets and fitting covers shall be neatly installed in a manner that does not compromise the integrity of the insulation vapor barrier.

## 2.6 INSULATION FOR HOT EQUIPMENT:

- A. The following hot equipment shall be insulated:
  - 1. Steam to Glycol/water Heat exchangers.
  - 2. Water heaters.
  - 3. Air separators.
  - 4. Flash tank.
  - 5. Condensate return tank and pumps.
  - 6. Trap assemblies.
- B. Equipment insulation shall be 2 inches thick, 14 pcf, asbestos free, rigid hydrous calcium silicate heat insulation which is resistant to abrasion or moisture damage. Insulation shall be cut or mitered to fit equipment contours and held in place with 3/4 inch wide galvanized steel bands, spaced at no more than 12 inches on center. All joints and voids shall be filled with mineral wool cement, wet trowelled into the openings and finished to a smooth, even surface. The entire surface shall be covered 1 inch hex pattern wire mesh with laced edges, secured in place by wiring to bands. Apply two coats (1/2 inch total thickness) of insulating cement. A final finish of 8 ounces canvas shall be adhered neatly in place with lagging adhesive and brush coated ready for final painting.
- C. Insulation of removable heat exchanger heads and other equipment access points shall be installed such that removal may be accomplished without damaging insulation.

## 2.7 INSULATION FOR COLD EQUIPMENT:

- A. Insulate air/dirt separator, expansion tanks, side stream filter vessels and chilled water pumps with Owens-Corning Series 705, 2 inches thick 6 lb density fiberglass.
- B. Insulation shall be cut to fit the shape and contour of the equipment and banded in place with galvanized steel bands. Point up all joints with insulating cement.
- C. Vapor seal shall consist of a layer of Ludlow Foil Barrier Paper smoothly adhered in place with

vapor barrier lap adhesive with all joints lapped a minimum of 80 mm (3 inches).

- D. Over vapor barrier, apply pre-sized 8 oz canvas adhered with lagging adhesive.
- E. Fabricate insulation covers on pumps such that pump cases can be dismantled without permanent damage to the insulation or vapor barrier. See Removable Insulation Cover details in drawing set.
- F. Provide sketch of proposed pump case insulation for Architect/Engineer approval prior to fabrication.
- G. Provide 9 mm aluminum jackets on outside of insulated equipment.

2.8 INSERT AND SADDLES:

- A. Insulated pipe must be supported by hangers on outside of insulation unless expressly permitted otherwise. Special high density inserts of Calcium Silicate, Cellular-Glass, Treated Wood Blocks or Glass Fiber minimum 8 lb. density, of the same thickness as adjacent insulation or as specified on drawings shall be installed at points of support. Inserts shall have a compression strength of not less than 100 psi.
- B. High density insulation inserts for steam service to be hydrous calcium silicate; ASTM/AMSI C533, rigid white, asbestos free, "k" value of 0.44 at 300 F.
- C. The entire insert shall be covered with vapor-barrier jacketing of the same material as the jacketing on adjacent covering.
- D. Metal shields Fed. Spec. WW-H-171, Type 41 as hangers shall be applied between hanger and insulation. Shields shall be galvanized or coated with corrosion resistant epoxy finish.
- E. Shields shall be minimum 18 ga, 180 degrees of the insulation surface arc, unless otherwise approved, inserts shall be 85° of the surface; lengths of inserts and U.S. gauges of shields shall be as listed below:

Nominal Pipe or Tubing Size, Inches	Insulation Density lbs/cu ft	Length Inches	Metal Length Inches	Saddle Gage No. U.S.	
1/2 to 3	8		12	12	18
4	10		12	12	16
5 & 6	12		18	18	16
8 & Up	14		24	24	14

- F. Depending on the type of pipe hanger or support and the spacing, the density of the insert and the gauge of the saddle may vary from the above table, with written approval from the Engineer. The Contractor shall submit details showing the method of insulation at pipe support or hangers.
- G. The complete installation shall be designed and installed in such a manner that the pipe is properly supported at all locations. There shall be no deformation along the entire pipe line.
- H. Where anchors are secured directly to low temperature piping, the members of the anchor,

external to pipe insulation, shall be lineally insulated not less than six inches to prevent condensation.

### PART 3 EXECUTION

#### 3.1 MANNER OF PERFORMING WORK:

- A. After testing for leaks, furnish and install thermal insulation for ventilating, heating, and cooling equipment, ducts and piping. Where piping and ducts pass through walls, floors or partitions, the opening in the construction around the piping and duct shall be packed with a fire-stop material to provide an effective barrier against the spread of fire, smoke and gases.
- B. Insulation material shall be installed in a first class manner with smooth and even surfaces, with jackets and facings drawn tight and smoothly fastened down at all longitudinal and end laps. Scrap pieces of insulation shall not be used where a full length section will fit. Adhesives, sealers, vapor barrier coatings, etc., shall be compatible with the materials to which they are applied, and shall not corrode, soften or otherwise attack such material in either the wet or dry state. Insulation materials shall not be applied until all surfaces to be covered are clean and dry, and all foreign material, such as rust, scale, dirt, etc., has been removed. Insulation shall be clean and dry when installed and during the application of any finish. Insulation shall be neatly finished at pipe and duct hangers. Pipe insulation shall be continuous through walls, floors, ceiling openings, hangers, supports and sleeves. Duct insulation shall be continuous through walls, floors, and ceiling openings, except at fire dampers. Piping and ductwork shall be individually insulated.
- C. All materials and finishes shall be installed in accordance with the approved recommendations and guidelines as issued by the respective manufacturers to conform to the contract documents. The installation shall be accomplished by workmen specifically skilled in this trade. A neat and workmanship like job is expected and will be required.

#### 3.2 APPLICATION OF HOT PIPE INSULATION:

- A. Piping:
  - 1. Insulation shall be installed with jackets drawn tight. End joint butt strips shall be not less than 2 inches wide and of identical material of jacket. Additionally, side laps and butt strips shall be secured with staples on 3 inch centers. Staples shall be epoxy coated steel outward clinched.
- B. Fitting, Flange and Valve Insulation:
  - 1. Where molded or mitered fitting covers are used, they shall be wired in place and covered with a smoothing coat of finishing cement, except oversized pipe covering.
  - 2. Where used, combination insulating and finishing cement shall be applied to a thickness equal to adjacent pipe insulation. Finish shall be Foster 30-36 with glass fabric reinforcement.
- C. Where piping is located in wall chases and space does not permit the installation of sectional insulation, the pipes may have the insulation omitted, provided the chases are packed full of mineral or rock wool.
- D. Insulation shall be continuous and shall extend full thickness through walls, floors, hangers, supports and sleeves. Pipe sleeves shall be selected accordingly.

#### 3.3 APPLICATION OF COLD PIPE INSULATION:

- A. Piping:
  - 1. Insulation shall be installed with jackets drawn tight, with jacket side-laps and end joint butt strips secured with lagging adhesive, Foster 30-36, or with factory applied self-sealing joints. End joint butt strips shall be not less than 2 inches wide and of identical material to jacket. Additionally side-laps and butt strips shall be secured with staples on 3 inch centers. Staples shall be epoxy coated steel, outward clinched. Staples and seams shall be sealed with a heavy brush coat of lagging adhesive. Provide complete continuous vapor barrier.
  - 2. Pipe insulation shall be done only when the ambient dewpoint is less than the temperature of the pipe. Insulation shall not be applied to pipe on which condensation is occurring.
- B. Fitting, Flange and Valve Insulation:
  - 1. Where molded or mitered fitting covers are used, they shall be wired in place and covered with a smoothing coat of finishing cement, except PVC covers or over-sized pipe covering. When PVC cover or oversized pipe covering is used, all joints including elbow throats shall be sealed with 2" wide glass lagging tape embedded in GPM mastic, no pressure sensitive tape will be allowed.
  - 2. Where used, combination insulating and finishing cement shall be applied to a thickness equal to adjacent pipe insulation. Finish shall be Foster 30-36 with reinforced glass fabric.
- C. Insulation shall be continuous and shall extend full thickness through walls, floors, hangers, supports, and sleeves. Pipe sleeves shall be selected accordingly.

#### 3.4 INSULATION FINISHES:

- A. Pipe and Fitting Insulation:
  - 1. In Plant, Tunnels and Exposed to Weather:
    - a. Pipe insulation shall be finished with 0.16 inch thick dimpled aluminum jacketing with vapor-barrier lining unless surface of the insulation to which the aluminum is applied is provided with a vapor barrier jacket. Side and end laps shall be at least 2 inches wide and cut edge of side lap shall be turned under one inch to provide a smooth edge. Laps shall be placed to shed water. Jackets shall be secured in place with aluminum bands on 18 inch centers. For pipe insulation furnished with factory aluminum jackets of equal thickness, proper longitudinal slip joints and butt straps may be used.
    - b. All fitting insulation shall be finished with factory fabricated dimpled aluminum covers. Tee, flange, and valve insulation shall be finished with job fabricated aluminum covers of the same thickness as jackets on adjacent covering. Vapor-barrier protection shall be provided under all jackets. Aluminum covers shall be secured in place with aluminum bands on 9 inch centers. Band fastening mechanism shall be oriented downward.

END OF SECTION



## SECTION 15520

### STEAM AND STEAM CONDENSATE PIPING AND VALVES

#### PART 1 GENERAL

##### 1.1 SECTION INCLUDES:

- A. Related sections.
- B. References.
- C. System description.
- D. Submittals.
- E. Piping arrangement
- F. Project record documents
- G. Operation and maintenance manual.
- H. Qualifications.
- I. Project specific welder certification procedure.
- J. Regulatory requirements.
- K. Delivery, handling and storage.
- L. Extra materials.
- M. Medium and high pressure steam piping.
- N. Steam condensate piping
- O. Steam pipe fittings.
- P. Unions, flanges and couplings.
- Q. Pipe hangers and supports.
- R. Valves.
- S. Preparation.
- T. Installation.
- U. Welding of steel pipe.
- V. Soldering of copper pipe.
- W. Tests.
- X. Cleaning pipe systems.
- Y. Pipe hanger schedule.

##### 1.2 RELATED SECTIONS:

- A. Section 15190 - Mechanical Identification.
- B. Section 15260 - Piping Insulation.
- C. Section 15525 - Steam and Steam Condensate Specialties.

##### 1.3 REFERENCES:

- A. ASME - Boiler and Pressure Vessel Codes, SEC 9 - Qualification Standard for Welding and Brazing Procedures, Welders, Brazers, and Welding and Brazing Operators.
- B. ASME B16.3 - Malleable Iron Threaded Fittings Class 150 and 300.
- C. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings.
- D. ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
- E. ASME B31.1 - Code for Power Piping.
- F. ASME B31.9 - Building Services Piping.

- G. ASTM A53 - Pipe, Steel, Black and Hot-Dipped Zinc Coated, Welded and Seamless.
  - H. ASTM A234 - Pipe Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures.
  - I. ASTM B32 - Solder Metal.
  - J. ASTM B88 - Seamless Copper Water Tube.
  - K. ASTM F708 - Design and Installation of Rigid Pipe Hangers.
  - L. AWS A5.8 - Brazing Filler Metal.
  - M. AWS D1.1 - Structural Welding Code.
  - N. MSS SP58 - Pipe Hangers and Supports - Materials, Design and Manufacturer.
  - O. MSS SP69 - Pipe Hangers and Supports - Selection and Application.
  - P. MSS SP89 - Pipe Hangers and Supports - Fabrication and Installation Practices.
- 1.4 SYSTEM DESCRIPTION:
- A. Steam, condensate and auxiliary piping within tunnels, plant and mechanical rooms.
  - B. When more than one piping system material is selected, ensure systems components are compatible and joined to ensure the integrity of the system is not jeopardized. Provide necessary joining fittings. Ensure flanges, unions, and couplings for servicing are consistently provided as required.
  - C. Use unions, flanges, and downstream of valves and at equipment or apparatus connections. Use dielectric unions where joining dissimilar materials. Do not use direct welded or threaded connections.
  - D. Provide pipe hangers and supports in accordance with ASTM B31.9 unless indicated otherwise.
  - E. Use gate valves for shut-off and to isolate equipment, part of systems, or vertical risers.
  - F. Use globe valves for throttling, bypass, or manual flow control services.
  - G. Piping arrangement:
    1. Follow piping arrangement and details; cut piping accurately to measurements established at site and install without springing or forcing. Locate piping and equipment to avoid interference with other piping and equipment including openings, electrical conduits and outlets. Mask suitable provisions for expansion and contraction with pipe offsets. Piping shall conform to ANSI Code for Pressure Piping. Clean piping and fittings before installation and ream all pipe after cutting threads, torch cutting and hand cutting.
    2. Provide small piping required in connection with instruments, gages, reducing valves, traps and other mechanical equipment not indicated on drawings. Provide drains, shut-off valves and cocks, syphons, and pulsation dampers.
    3. Provide union or flange at each connection to equipment, on both sides of control valves, downstream of each valve, at each strainer and trap. Install unions at both ends of

valves, strainers, and like items when valves, etc., are specified in welded steel piping, install screwed flanges.

4. Connect new work to existing work in a neat and workmanlike manner. Where an existing surface must be cut, or existing utilities interfere, such obstructions shall be bypassed, removed replaced or relocated, patched and repaired. Work disturbed or damaged shall be replaced or repaired to its prior condition. Replaced or relocated piping shall be of the same material, type, class and size as the existing, unless otherwise approved.

#### 1.5 SUBMITTALS:

- A. Product Data: Provide data on pipe materials, pipe fittings, valves and accessories. Provide manufacturers catalogue information. Indicate valve data and ratings.
- B. Welders Certificate: Include welders qualifications and certification of compliance with ASME/SEC 9 as described in this section.
- C. List of project specific certified welders and identification symbols.
- D. Spool drawings shall be provided by the Contractor and submitted to the Engineer for review prior to any field or shop fabrication. Spool drawings to be isometric drawings showing pipe, hanger location and equipment connectors, with critical dimensions indicated. Hand drawn sketches on 8 1/2" x 11" paper are acceptable, provided they are legible, dated and signed by the Contractor.
- E. Manufacturer's Installation Instructions: Indicate hanging and support methods, joining procedures.

#### 1.6 PROJECT RECORD DOCUMENTS:

- A. Record actual locations of valves, traps, expansion joints.

#### 1.7 OPERATION AND MAINTENANCE DATA:

- A. Maintenance Data: Include installation instructions, spare parts lists, exploded assembly views.

#### 1.8 QUALIFICATIONS:

- A. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.
- B. Installer: Company specializing in performing the work of this section with minimum three years documented experience.
- C. Welders: Certify in accordance with ASME SEC 9.

#### 1.9 PROJECT SPECIFIC WELDER CERTIFICATION PROCEDURE:

- A. All welding shall be in accordance with ASME B31.1 (latest edition).
- B. All workers performing pipe welds for this project, either in off site shop fabrication or in field assembly shall be certified to a set of job specific Welding Procedure Specifications (WPS) as described below.

- C. The contractor will prepare and qualify the Welding Procedure Specification for the type and grade of pipe to be used in representative size indicated below:
  - 1. 8" pipeweld for steam, condensate.
- D. The individual qualifications of the workers shall be performed by an independent testing agency approved by the owner. The individual qualifications will be done on the project job site, in an area established by the contractor, and using the contractors equipment and materials.
- E. The contractor shall be responsible for scheduling the testing with the independent testing agency and shall provide the owner with 48 hour advance notice and allow owners representative to witness the testing procedure.
- F. The contractor shall include all costs associated with preparation and qualification of welding procedures, certification of welders and any independent testing agency fees in his bid.
- G. Following certification, the contractor shall provide each welder with a unique stamped employing letters a minimum of 1/4" high. Each and every pipe weld or braze installed on this project shall be stamped. Contractor shall submit prior to commencing any work and provide monthly updates of names and stamp identification for all pipe welders working on this project.
- H. Unstamped welds or brazes will be rejected, removed, and replaced by Project Specific Certified personnel at no additional cost to owner.

1.10 REGULATORY REQUIREMENTS:

- A. Conform to ASME B31.9 code for installation of piping system.
- B. Welding Materials and Procedures: Conform to ASME SEC 9.

1.11 DELIVERY, STORAGE, AND HANDLING:

- A. Deliver, store, protect and handle products to site in accordance with manufacturer's recommendations.
- B. Accept valves and expansion joints on site in shipping containers with labeling in place. Inspect for damage.
- C. Provide temporary protective coating on cast iron and steel valves.
- D. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.
- E. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

1.12 EXTRAMATERIALS:

- A. Provide two of repacking kits for each size and valve type.

PART 2 PRODUCTS

2.1 MEDIUM AND HIGH PRESSURE STEAM AND CONDENSATE PIPING (150 PSIG MAXIMUM):

- A. Steel Pipe: ASTM A53, seamless black, domestic manufacturer SCH 80 for all pipe less than 3 inches, SCH 40 for 3 inches and above.
  - 1. Fittings: ASTM B16.3 malleable iron Class 250, or ASTM A234 forged steel welding type, Class 300.
  - 2. Joints: Threaded, or AWS D1.1 welded.

2.2 STEAM AND CONDENSATE PIPE FITTINGS:

- A. 2 inches and below shall be malleable iron, 150 lb. Class screwed ANSI B16.3.
- B. 2-1/2" and larger shall be forged carbon steel, butt weld, wall thickness equal to pipe, ANSI B16.9. Welding fittings shall conform to class of pipe on which installed and shall have beveled ends for butt welding with radius of elbows not less than normal diameter of corresponding pipe and long radius unless otherwise indicated. Tees shall be full size or reducing as required, having interior surfaces smoothly contoured. Tees shall be forged or fabricated from longitudinally welded rolled cylinders. Fabricated tee branches shall be extended and stress relieved per ASTM A 234-84a. Saddling or field fabricating of branches shall not be accepted. Forged tees shall be Tube Turns #21 or approved equal. Welding outlet fittings shall be ASTM A 105 GR2, forged integrally reinforced to provide 100 percent pipe strength, beveled for full penetration welding and funneled at inlet for full fluid flow. Connection outlet fittings shall be Weld-o-let or Thread-o-let or approved equal. Pipe fittings shall be domestic manufacturer.

C. Bolting:

- 1. Bolting shall conform to the requirements of ANSI B15.5. All bolt and nut threads shall conform to ANSI B1.1. Alloy steel bolting shall be used for joining all raised face steel flanges having a design pressure Class 150 psi or greater, and the material shall conform to the following:

Bolting studs and bolts	ASTM A 193 Grade B7
Nuts	ASTM A 194 Grade 2H

- 2. Carbon steel bolting shall be used for joining all flat faced and other iron and steel flanges. Bolts and nuts shall be heavy hexagonal head and the material shall conform to the following:

Bolting studs and bolts	ASTM A 307 Gr B
Nuts	ASTM A 563 Gr A

- 3. Buried bolting shall be cadmium-plated in accordance with ASTM A 165 or zinc-coated in accordance with ASTM A 153.

- 4. Bolting in non-ferrous flanges and flanged fittings shall conform to the following:

Bolting studs and bolts	ASTM A 307 Gr B, Cadmium-plated	Nuts
	ASTM B 16	

- 5. Thread lubricant shall be used as required.

2.3 UNIONS, FLANGES, AND COUPLINGS:

- A. Unions for Pipe 2 Inches and Under:

1. Ferrous Piping: 150 psig malleable iron, threaded.
- B. Flanges for Pipe Over 2 Inches:
1. Ferrous Piping: 150 psig forged steel, weld neck, raised face ANSI B16.5.
  2. Gaskets: 1/16 inch thick preformed non-asbestos graphite fiber.
- C. Dielectric Connections: Union with galvanized or plated steel threaded end, copper solder end, water impervious isolation barrier.
- 2.4 PIPE HANGERS AND SUPPORTS:
- A. Conform to ASME B31.9
  - B. Hangers for Pipe Sizes 1/2 to 1-1/2 Inch: Carbon steel, adjustable swivel, split ring.
  - C. Hangers for Pipe Sizes 2 to 4 Inches: Carbon steel, adjustable, clevis.
  - D. Hangers for Pipe Sizes 6 Inches and Over: Adjustable steel yoke, cast iron roll, double hanger.
  - E. Multiple or Trapeze Hangers for Pipe Sizes to 4 inches: Steel channels with welded spacers and hanger rods.
  - F. Multiple or Trapeze Hangers for Pipe Sizes 6 Inches and Over: Steel channels with welded spacers and hanger rods; cast iron roll and stand.
  - G. Wall Support for Pipe Sizes to 3 Inches: Cast iron hook.
  - H. Wall Support for Pipe Sizes 4 to 5 Inches: Welded steel bracket and wrought steel clamp.
  - I. Wall Support for Pipe Sizes 6 Inches and Over: Welded steel bracket and wrought steel clamp; adjustable steel yoke and cast iron roll.
  - J. Vertical Support: Steel riser clamp.
  - K. Floor Support for Pipe Sizes to 4 Inches: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
  - L. Floor Support for Pipe Sizes 6 Inches and Over: Adjustable cast iron roll and stand, steel screws, and concrete pier or steel support.
  - M. Copper Pipe Support: Carbon steel ring, adjustable, copper plated.
  - N. Hanger Rods: Mild steel threaded both ends, threaded one end, or continuous threaded.
  - O. Inserts: Malleable iron case of galvanized steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms; size inserts to suit threaded hanger rods.
- 2.5 VALVES:
- A. Globe Valves:

1. 4" and Larger: Cast steel crane 351 rated to 400°F.
  2. 3" and Smaller: Crane 7TF threaded bronze globe valves, union bonnet, renewable disc, 150# SWP.
- B. Gate Valves:
1. 3" and Smaller: Crane 431 UB threaded bronze gate valves, union bonnet, rising stem, solid edge, 150# SWP.
- C. Check Valves:
1. 3" and Smaller: Crane 137 threaded bronze check valves, screwed bonnet, renewable disc, 150# SWP.
- D. Ball Valves:
1. 3" and Smaller: Crane 9303, threaded bronze ball valves, full port, 150# SWP.
- E. Plug Valves: For condensate return greater than 1", DeZurick PEC rated to 300°F.

### PART 3 EXECUTION

#### 3.1 PREPARATION:

- A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.
- B. Remove scale and dirt on inside and outside before assembly.
- C. Prepare piping connections to equipment with flanges or unions.
- D. Keep open ends of pipe free from scale and dirt. Whenever work is suspended during construction protect open ends with temporary plugs or caps.
- E. After completion, fill, clean, and treat systems.

#### 3.2 INSTALLATION:

- A. All materials and equipment shall be installed in accordance with the approved recommendations and guidelines as issued by the respective manufacturers to conform with contract documents. The installation shall be accomplished by workmen skilled in the trade involved.
- B. Install gauges, thermometers, valves and devices and equipment to facilitate ease in reading operating and maintaining said devices. Locate and position thermometers and gauges for easy readability by operator or staff standing on floor or walkway provided. Servicing shall not require dismantling adjacent equipment or pipe work.
- C. Follow piping arrangement and details cut piping accurately to measurements established at site and installed without spring or forcing. Unless otherwise indicate, piping shall be aligned to be parallel to building lines. Vertical piping shall be plumb. Locate piping and equipment to avoid interference with other piping and equipment including openings, electrical conduits and outlets. Make suitable provisions for expansion and contraction with pipe offsets. Piping shall conform to ANSI Code for Pressure Piping. For roof mounted pipe support provide pitch pockets.

- D. Provide small piping required in connection with instruments gauges, reducing valves, traps and other mechanical equipment not indicated on drawings. Provide drains, shut-off valves and cocks, syphons, and pulsation dampers.
- E. Connect new work to existing work in a neat and workmanlike manner. Where an existing surface must be cut, or existing utilities interfere, such obstructions shall be bypassed, removed, replaced or relocated, patched and repaired. Work disturbed or damaged shall be replaced or repaired to its prior condition. Replaced or relocated piping shall be of the same material, type, class and size as the existing, unless otherwise approved.
- F. Install piping to conserve building and tunnel space and not interfere with use of access space.
- G. Sleeve pipe passing through partitions, walls, and floors. Sleeve to extend above floor by 6 inches minimum.
- H. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
- I. Inserts:
  - 1. Provide inserts for placement in concrete formwork.
  - 2. Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
  - 3. Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 4 inches.
  - 4. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
  - 5. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut.
- J. Pipe Hangers and Supports:



1. Install in accordance with ASTM B31.9.
  2. Support horizontal piping as scheduled.
  3. Place hangers within 12 inches of each horizontal elbow.
  4. Use hangers with 1-1/2 inch minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe. All hangers and supports shall be capable of screw adjustment after piping is connected and shall be finally adjusted vertically and horizontally under operating conditions.
  5. Support vertical piping at every floor. Support riser piping independently of connected horizontal piping.
  6. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
  7. Prime coat exposed steel hangers and supports. Refer to Section 09900. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.
- K. Provide clearance for installation of insulation and access to valves and fittings.
- L. Slope steam piping one inch in 40 feet in direction of flow or as indicated. Use eccentric reducers to maintain bottom of pipe level.
- M. Slope steam condensate piping one inch in 40 feet or as indicated. Provide drip trap assembly at low points and before control valves. Run condensate lines from trap to nearest condensate receiver. Provide loop vents over trapped sections.
- N. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welds.
- O. Prepare unfinished pipe, fittings, supports, and accessories ready for finish painting. Refer to Section 09900.
- P. Install valves with stems upright or horizontal, not inverted.
- Q. Protect pipe covering at each support with steel protection saddles or rigid insulation inserts and minimum 18 ga. Shields that will transmit the load of the pipe line directly to the support without damage to the covering.
- R. High Density Insulation Inserts for Insulated Pipe: Hydrous calcium silicate; ASTM/ANSI C533; rigid white; asbestos free; "K" value of 0.44 at 300 degrees F.

### 3.3 WELDING OF STEEL PIPE:

- A. The Contractor shall inform the Owner's Construction Representative a minimum of 48 hours in advance of any intended welding operations inside or within 100 feet of the building or tunnel, and shall provide a fire guard and a suitable fire extinguisher at the welding site at all times when welding is in progress.
- B. When working in utility tunnels, Contractor shall provide supply, exhaust fans and temporary sheet plastic draft stops.

- C. Before assigning any welder to work, the Contractor shall provide certification to the Owner's Construction Representative that each welder has passed qualification tests as prescribed herein.
- D. Contractor shall weld ferrous pipe 2-1/2 inches and larger. Branch connections 2-1/2 inches and larger shall be made with welding tees. Pipe bends made with two-1/2 mitre welds, field fabricated fittings including laterals, shaped nipples and tees, altering of flanged tees, notching straight runs to form tees or any other similar type of construction is not acceptable unless otherwise explicitly specified. "Weld-O-Lets" or similar fittings may be used provided that the entire root of the fitting is completely filled with weld material so that the circumferential root is filled flush with the outside surface of the fitting. This requires multiple welding passes. Steel butt-welding fittings shall be as strong or stronger than the pipe schedule number specified.
- E. Welded pipe connections shall be done by electric-arc welding, and shall conform to the recommendations and rules of the Standard Manual on Pipe Welding, published by the Mechanical Contractor's Association, the American Welding Society, and applicable portions of the ASME Boiler and Pressure Vessel Code. Electrodes for welding shall conform to ASTM A-233, and shall be one of the following classes: E6010, E6011, E6016, or E6020.
- F. Contractor shall be responsible for the proper storage of all welding rod, electrodes, and filler metal (i.e., storage of low hydrogen type electrodes in heated ovens).
- G. Preheat welding area to "hand-hot" if ambient temperature is below 32°F.
- H. All welds are subject to inspection by the Owner's Construction Representative. Non Destructive Evaluation (NDE) including radiographic testing by an independent testing laboratory, may be done at Owner's option. Costs for initial testing will be borne by Owner. If the weld is not satisfactory, the unacceptable area will be removed and rewelded by the Contractor, at no additional cost to the Owner. Costs for retesting of the weld will be borne by Contractor. Pipe and attachment welds are also subject to dye penetration testing, at the discretion of the Owner's Construction Representative.

#### 3.4 SOLDERING OF COPPER PIPE:

- A. Solder Joints: Cut tubing with square ends, remove all burrs, fins and dents and resize if necessary. At each joint, mark tubing with scribe line one inch plus the depth of the socket, measured from the end of the tubing and clean tubing and socket with solvent, then clean with emery cloth. Coat tubing end and inside of socket with thin film of flux, insert tubing full depth into socket and twist to spread flux. Heat socket to correct temperature to melt solder, remove flame, apply solder to edge of socket or to solder hole and completely fill joint, holding joint rigidly in position during soldering and until solder has hardened. While joint is hot, remove excess solder and flux with cloth or brush. Take care to prevent annealing of copper tubing when making connections.

#### 3.5 TESTS:

- A. General: All piping shall be tested as specified herein and approved by Owner before being insulated or otherwise concealed in any way. All tests will be performed with the Owner present. All tests to be documented with time, date, type of system, test material used, kind and duration of test with results, and signatures (not initials) of those present. Any leaks shall be repaired by replacing the defective element with procedures equivalent to new. Peening, caulking partial welding or brazing, etc., shall not be accepted. Clean all piping systems in accordance with individual specification sections and Section 15480.
- B. Procedures, General:

1. Comply with procedural standards of certifying association under whose standards service will be performed.
2. Notify Owner three (3) days prior to beginning of operations and prior to system testing.
3. Accurately record data for each step.
4. Report to Owner any defects or deficiencies noted during performance of services.
5. Test all piping systems as specified herein.
6. Perform testing of all plumbing piping and equipment.

C. Specific Tests:

1. Steam Piping: Test to 250 psi, hydrostatic pressure with no pressure drop in four (4) hours.
2. Condensate Piping: Test to 100 psi, hydrostatic pressure with no pressure drop in four (4) hours.

D. Acceptance: Prior to acceptance of completed piping installation, Contractor shall subject system to such tests as may be required by Architect/Engineer to demonstrate satisfactory functional and operational efficiency. These tests shall cover a period of not less than 6 hours for each complete piping system tested. Conduct tests at such times as Owner/Engineer may direct. Calibrated instruments, equipment, facilities and labor required to properly conduct tests shall be provided by Contractor at no additional cost. Repeat tests without cost, if failures occur.

E. Reports: Submit written certification of date and time of acceptance of testing procedures to the Owner/Engineer.

3.6 CLEANING PIPING SYSTEMS:

- A. Contractor is responsible for procuring introducing chemicals to be provided by Chemical Treatment Vendor, circulating chemicals, draining, flushing and refilling. Refer to Section 15545 – Chemical Treatment, for specific water treatment requirements.
- B. After piping systems have been tested and proven tight, clean piping systems of dirt, scale, oil, grease, waste and other foreign substances which may have accumulated during process of installation. Strainer screens shall be removed, cleaned and replaced after cleaning flushing process is completed.
- C. After each system has been thoroughly and satisfactorily cleaned all low points “blown-down”, interiors of strainers reinstalled, all temporary by-passes removed, systems filled with clean water, chemical treatment added and control valves adjusted, all systems shall be permanently connected.
- D. Provide Owner 48 hour advance notice prior to any pipe cleaning and provide written certification that cleaning has occurred, and that strainer screens have been cleaned, prior to system activation.

3.7 SCHEDULES:

A. Provide piping support hangers to ensure that no sags occur. Minimum hanger rod sizing and maximum hanger spacing shall conform to following table:

<u>Pipe Size</u>	<u>Spacing</u>	<u>Hanger Rod</u>	
1. Steel Pipe:	1/2"	6'-0"	3/8"
	3/4" through 1-1/4"	8'-0"	3/8"

1-1/2", 2"	10'-0"	3/8"
2-1/2"	10'-0"	1/2"
3"	12'-0"	1/2"
4"	12'-0"	5/8"
5"	12'-0"	5/8"
6"	12'-0"	3/4"
8"-12"	12'-0"	7/8"

2. Copper Pipe:

1/2"	6'-0"	3/8"
3/4", 1"	8'-0"	3/8"
1-1/4" through 2"	10'-0"	3/8"
2-1/2" through 5"	12'-0"	1/2"
6" and above	12'-0"	3/4"

END OF SECTION

## SECTION 15525

### STEAM AND STEAM CONDENSATE SPECIALTIES

#### PART 1 GENERAL

##### 1.1 SECTION INCLUDES:

- A. Steam traps.
- B. Steam air vents.
- C. Flash Tanks.
- D. Condensate return units.
- E. Pressure reducing valves.
- F. Temperature indicators and wells.
- G. Pressure indicators and points.
- H. Steam safety valves.
- I. Expansion Compensation.
- J. Condensate Meter

##### 1.2 RELATED SECTIONS:

- A. Section 15170 - Motors: Pump Motors.
- B. Section 15260 - Piping Insulation.
- C. Section 15280 - Equipment Insulation.
- D. Section 15520 - Steam and Steam Condensate Piping.

##### 1.3 REFERENCES:

- A. ASME - Boiler and Pressure Vessel Codes, SEC 8-D - Rules for Construction of Pressure Vessels.
- B. ASME B31.9 - Building Services Piping.
- C. ASTM A105 - Forgings, Carbon Steel, for Piping Components.
- D. ASTM A126 - Grey Iron Castings for Valves, Flanges, and Pipe Fittings.
- E. ASTM A216 - Steel Casings, Carbon, Suitable for Fusion Welding, for High Temperature Service.
- F. ASTM A395 - Ferric Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures.

##### 1.4 SYSTEM DESCRIPTION:

- A. Accessories for steam and condensate piping systems:

##### 1.5 PERFORMANCE REQUIREMENTS:

- A. Steam Traps:
  - 1. Select to handle minimum of two times maximum condensate load of apparatus served.
  - 2. Pressure Differentials:
    - a. Low Pressure Systems 15 psi maximum: 2 psi.

##### 1.6 SUBMITTALS:

- A. Product Data:

1. Provide for manufactured products and assemblies required for this project.
  2. Include product description, model, dimensions, component sizes, rough-in requirements, service sizes, and finishes.
  3. Submit schedule indicating manufacturer, model number, size, location, rated capacity, load served, and features for each specialty.
  4. Include electrical characteristics and connection requirements as applicable.
- B. Manufacturer's Installation Instructions: Indicate application, selection, and hookup configuration. Include pipe and accessory elevations.
- 1.7 OPERATION AND MAINTENANCE DATA:
- A. Operation and Maintenance Data: Include installation instructions, servicing requirements, and recommended spare parts lists.
- 1.8 QUALIFICATIONS:
- A. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.
- 1.9 REGULATORY REQUIREMENTS:
- A. Conform to ASME B31.9 code for installation of steam and steam condensate piping and specialties.
- 1.10 DELIVERY, STORAGE, AND HANDLING:
- A. Deliver, store, protect and handle products to site in accordance with manufacturer's recommendations.
  - B. Accept valves on site in shipping containers with labeling in place. Inspect for damage.
  - C. Provide temporary protective coating on cast iron and steel valves.
  - D. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.
  - E. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.
- 1.11 EXTRAMATERIALS:
- A. Furnish under provisions of Section 01700.
  - B. Provide two service kits for each size and type of steam trap.
  - C. Provide one set of mechanical seals for each pumps.

PART 2 PRODUCTS

2.1 FLOAT AND THERMOSTATIC TRAPS (INCLUDING CHILLER TRAPS):

- A. Manufacturers:
  - 1. Armstrong.
- B. Trap:
  - 1. Inverted bucket traps with cleaning pin designed for amine use
  - 2. Rating: 15 psig, 125 psig as required.
  - 3. Features: Access to internal parts without disturbing piping, bottom drain plug.
  - 4. Accessories: Gage glass with shut-off cocks.

2.2 STEAM AIR VENTS:

- A. 125 psig WSP:
  - 1. Balanced Pressure Type: Cast brass body and cover; access to internal parts without disturbing piping; stainless steel bellows, stainless steel valve and seat.

2.3 FLASH TANKS:

- A. Tank:
  - 1. Closed type, tested and stamped in accordance with ASME SEC 8-D, welded steel construction, cleaned, prime coated, and supplied with steel support legs.
  - 2. Working Pressure: 125 psig.
  - 3. Construct with nozzles and tapings for installation of accessories and piping connections.

2.4 CONDENSATE RETURN UNIT:

- A. Furnish and install Duplex condensate return unit(s) as shown on the drawings. Each unit shall consist of 1 elevated cast iron receiver, 1 inlet strainer, 2 water pumps, 2 float switches, 1 NEMA I consolidated control panel and all accessories as hereinafter specified.
- B. The condensate receiver shall be of close grained cast iron construction, elevated 24" on fabricated steel frame and shall be furnished with: (2) externally adjustable 2-pole float switches, water level gauge, dial thermometer, (2) dial pressure gauges for pump discharges, (2) suction piping with all bronze isolation ball valves between pump suction and receiver and (2) lifter eye bolts.

A cast iron inlet strainer with vertical self-cleaning bronze screen and large dirt pocket shall be mounted on the receiver.

- C. The water pumps shall be two-stage, centrifugal design, permanently aligned and flange mounted for vertical operation. Each pump shall be bronze fitted with enclosed bronze fitted with enclosed bronze centrifugal impeller, axial flow, bronze first-stage impeller, bronze straightening vanes, renewable bronze case ring and stainless steel shaft. Mechanical seals shall be suitable for 250°F operation. Each pump shall be close-coupled to a 3,500 rpm, vertical, drip-proof motor and shall deliver its full capacity at boiling temperature, or at 2 ft. NPSH (net positive suction head). Capacities and electrical characteristics for the pumps shall be as scheduled on the drawings.

- D. Furnish, mount on the unit and wire, a NEMA 4 control cabinet with piano hinged door and grounding lug, enclosing the following: (2) Combination magnetic starter (having 3 overload relays) with circuit breaker and cover interlock, (1) electrical alternator, (2) "Auto-off-Hand" selector switch, (1) numbered terminal strip, (1) removable control mounting plate, (1) fusible control circuit transformer for each circuit when the motor voltage exceeds 130 volts.

Each pump control circuit shall be completely independent of the other. The electrical alternator shall (1) change the operating sequence automatically after each cycle, (2) provide simultaneous operation under peak load conditions and (3) operate the second pump automatically, should the active pump or its controls fail.

All factory installed wiring shall be numbered for each identification and the numbers shall coincide with those shown on the wiring diagrams.

Selector switches – "Auto-off-Hand" selector switches provide a means of shutting off pumps and a means of testing in the "Hand" position. "Off-Hand-Lead-Lag" selector switches may be furnished on duplex units with 2 float switches to provide manual alternation. Use only when magnetic starters are provided.

Manual Sequence Control (Lead-Lag) – for duplex units, consists of 2 selector switches used in conjunction with 2 magnetic starter and 2 level switches. The control provides for, (1) manual selection of the active pump, (2) simultaneous operation of both pumps under abnormal load conditions and (3) automatic operation of the inactive or lag pump if the lead pump or its controls fail.

- E. The unit shall be factory tested as a complete unit and the manufacturer shall furnish complete elementary and connection wiring diagrams, piping diagrams and installation and operation instructions. The unit shall be shipped complete assembled.

- F. Unit shall be ITT Domestic or prior approved equal.

## 2.5 PRESSURE REDUCING VALVES:

- A. Provide steam pressure regulators having capacities as scheduled and indicated on plans. Regulators shall be furnished with pressure pilot, inlet and outlet pressure gauges with cocks, inlet and outlet valves, inlet strainer with blowdown valve and globe valved by-pass line installed at the same plane as the main. Valves shall be cast iron body, 150 psi pattern with phosphor bronze diaphragm, renewable stainless steel seat and disc. Pilot valve shall be piped to the main valve and the out let side of the main. The line to the outlet side of the main shall pitch downward in the direction of flow. The first outlet side elbow shall be located at least ten outlet pipe diameters from the regulator.
- B. Valves shall be sized such that flow characteristics will be no less than 4000 fpm nor more that 7000 fpm.
- C. The outlet piping of each regulator station shall include an ASME rated and properly sized relief valve, independently vented to the atmosphere. Fit the bottom of each vent riser with a drip-pan elbow and pipe drain outlets to the nearest available floor drain.
- D. Pressure regulators shall be Fisher 92B or prior approved equal.

## 2.6 SAFETY RELIEF VALVES:

- A. Manufacturers:



1. Fisher.
  - B. Valve: Bronze body, stainless steel valve spring, stem, and trim, direct pressure actuated, capacities ASME certified and labeled.
  - C. Accessories: Drip pan elbow piped to nearest drain as shown on drawings, with vent through roof.
- 2.7 TEMPERATURE INDICATORS & WELLS: (TI, TW)
- A. Temperature Indicators: Bi-metal dial thermometer, 1% accuracy, 5 inch dial whit face, black figures, hermetically sealed with zero adjustment, friction pointer, stainless steel ring, case and stem. Back connection, adjustable angle, Trerice B8560, Ashcroft or approved equal. Each temperature indicator shall be supplied with a 304 stainless steel built-up well as specified below, with 3/4 NPT pipe connection. Coordinate required stem lengths.
  - B. Temperature Wells: shall be furnished and coordinated by the temperature indicator manufacturer. Wells shall be constructed of 304 stainless steel to the proper depth, with 3/4 NPT pipe connection, and extension neck for insulated lines. Wells shall be furnished with screw plug attached to wells with chain to keep dirt out when not in use. 3/4 inch threadlets shall be welded to the pipe to receive wells. Direct welding of wells in the pipeline will not be permitted. Adequate clearance shall be provided adjacent the wells to allow for thermometer insertion in proper position. Provide fixed flange for duct mounted indicators.
- 2.8 PRESSURE INDICATORS AND POINTS: (PI, PP)
- A. Pressure Indicators: 4-1/2 dial, cast aluminum case, dial range approximately 200 percent normal system pressure provided not less than 150 percent maximum system pressure, phosphor bronze bourdon tube, Trerice 500X, Ashcroft, or approved equal. Stop valves and snubbers shall be provided for each pressure indicator, installed between the service line and gauge. Provide coil syphons on steam service. Provide friction pointer on all gauges.
  - B. Pressure Points: Shall be constructed of 1/4 inch threadlets welded to the pipe, extension nipple, stop valve snubber, connection nipple and cap. Direct welding of extension nipple to the pipeline will not be permitted. Adequate clearance shall be provided above the pressure point to allow for proper gauge insertion.
- 2.9 EXPANSION COMPENSATION:
- A. Steam: Expansion joints shall be Yarway Gun-Pakt with stainless steel sleeve. Sleeve ends to be fitted with forged steel pipe flanges. All steam expansion joints shall be capable of 6 inch travel.
  - B. Condensate Return: Expansion joints shall be Hyspan 3501. Flanged end. All condensate expansion joints shall be capable of 4 inch travel.
  - C. Provide matched spyder type guides (4 per joint) for each steam and condensate joint.
- 2.10 CONDENSATE METER:
- A. General: The Condensate Meter shall consist of a metal housing, rotary volumetric measuring drum and a totalizer. The fluid shall be measured by isolating the flow in a scroll-shaped container, six of which shall be provided in the drum.
  - B. Materials of Construction: The meter shall be constructed of materials that are mutually compatible in steam condensate service. The casing shall be constructed of cast iron. The

metering drum shall be constructed of machine formed copper. All joints shall be full penetration welds using welding rod of suitable composition for the base metal. Fittings, fasteners and brackets shall be constructed of Rulon Gold. External parts such as totalizers may be constructed of high temperature polymers capable of withstanding temperatures as high as 350° F at 100% relative humidity.

- C. Assembly: All metering drum seams shall be readily accessible for visual inspection. Meter parts shall also be easily accessed for maintenance and replacement and shall be arranged to operate without vibration within +/- 1% accuracy throughout the entire range from 0-100% full rated capacity.
- D. Totalizer: Meter shall be equipped with a totalizer which shall indicate the quantity of fluid that has passed through the meter since the last reading. Such totalizer shall require no external power source and shall provide a separate contact closure interface to CPAS.
- E. Condensate meter shall be Cadillac or approved equal.

### PART 3 EXECUTION

#### 3.1 INSTALLATION:

- A. Install specialties in accordance with manufacturer's instructions.
- B. Steam Traps:
  - 1. Provide minimum 3/4 inch size on steam mains and branches.
  - 2. Install with union or flanged connections at both ends.
  - 3. Provide ball valve and strainer at inlet, and ball valve and check valve at discharge.
  - 4. Provide minimum 10 inch (250 mm) long, line size dirt pocket between apparatus and trap.
- C. Remove thermostatic elements from steam traps during temporary and trial usage, and until system has been operated and dirt pockets cleaned of sediment and scale.
- D. In high pressure and medium pressure mains, provide 3/4 inch nipple in bottom of main, extending 3/4 inch into and above bottom of pipe. Provide dirt pocket with 1/2 inch high pressure thermostatic trap.
- E. Provide pressure reducing stations with pressure reducing valve, valved bypass, strainer and pressure gage on upstream side, relief valve and pressure gage on downstream side of pressure reducing valve.
- F. Pressure reducing station shall be one or two stages as indicated, to produce flat reduced pressure curve over range of capacity. Locate pilot operator control minimum 6 feet downstream of valve.
- G. Rate relief valves for pressure upstream of pressure reducing station, for full operating capacity. Set relief at maximum 20 percent above reduced pressure.
- H. Terminate relief valves to outdoors 2 feet (600 mm) minimum above roof. Provide drip pan elbow with drain connection to nearest floor drain.

- I. When several relief valve vents are connected to a common header, header cross section area shall equal sum of individual vent outlet areas.

END OF SECTION

## SECTION 15545

### CHEMICAL WATER TREATMENT

#### PART 1 GENERAL

##### 1.1 SECTION INCLUDES:

- A. Description of interface between Contractor and Water Treatment Provider.
- B. Cleaning of piping systems.
- C. Chemical monitoring, control and feeding.
- D. Chemical treatment.

##### 1.2 DESCRIPTION OF INTERFACE BETWEEN CONTRACTOR AND WATER TREATMENT PROVIDER:

- A. A portion of the chemical water treatment system materials, components, equipment, and systems may be furnished, installed, started, and maintained under separate contract to the Owner's Campus Water Treatment Provider (WTP) at the option of PPD Utilities Division.

In addition, PPD Utilities Division will provide consultation, approval and oversight for cleaning, circulating and flushing of the piping systems prior to startup.

The following section describes the interface between the Contractor and the Owner for the installation, startup, commissioning, and maintenance of the chemical water treatment system.

- B. Equipment, materials, components, and services are identified as:
  - 1. Owner Furnished, Owner Installed (OFOI) if they are to be provided, installed, and warranted under separate contract between the Owner and its Water Treatment Provider.
  - 2. Contractor Furnished, Contractor Installed (CFCI) if they are to be provided, installed, and warranted under the construction contract.
  - 3. Owner Furnished, Contractor Installed (OFCI) if they are to be furnished by the Water Treatment Provider for installation or use by the Contractor.

##### 1.3 OFOI MATERIALS, COMPONENTS, EQUIPMENT AND SERVICES:

- A. As Described Below.
  - 1. Solution metering pumps, monitoring equipment and injection piping.
  - 2. Solution tanks (except sulfuric acid tank specified in 15120).
  - 3. Level switches.
  - 4. Chemical treatment water meters.
  - 5. Conductivity and pH controllers.
  - 6. Solenoid valves.
  - 7. Timers.
  - 8. Treatment chemicals.
  - 9. Control wire and conduit including wire and conduit to solenoid valves.
  - 10. Automatic controller.
  - 11. Start up, testing and commissioning of chemical treatment system.

1.4 CFCI MATERIALS, COMPONENTS, EQUIPMENT, AND SERVICES:

A. As Described Below:

1. Primary Plant Water meter.
2. Sulfuric acid tank (Section 15120).
3. Bypass feeder.
4. Coupon rack.
5. Pipe taps, isolation valves, chemical treatment, piping, power wiring, and conduit.

1.5 OFCI MATERIALS, COMPONENTS, EQUIPMENT, AND SERVICES:

A. As Described Below:

1. Circulation chemicals for cleaning.
2. Miscellaneous chemical treatment pipe systems and accessories.

1.6 REFERENCES:

- A. NFPA 70 - National Electrical Code.

1.7 SUBMITTALS:

- A. Submit CFCI materials, components, systems, and services under provisions of Section 01300.
- B. Shop Drawings: Indicate CFCI system schematic, equipment locations, and controls schematics, electrical characteristics and connection requirements.
- C. Product Data: Provide CFCI chemical treatment materials, chemicals, and equipment including electrical characteristics and connection requirements.
- D. Manufacturer's Installation Instructions: Indicate placement of CFCI equipment in systems, piping configuration, and connection requirements.
- E. Manufacturer's Field Reports: Indicate start-up of treatment systems when completed and operating properly. Indicate analysis of system water after cleaning and after treatment. Provide written documentation of review and approval by Owner.

1.8 PROJECT RECORD DOCUMENTS:

- A. Record actual locations of all equipment and piping, including sampling points and location of chemical injectors. Record documents to indicate CFCI, OFCI, and OFOI equipment and piping.

1.9 OPERATION AND MAINTENANCE DATA:

- A. Operation and Maintenance Data: Owners water treatment vendor to provide data on chemical feed pumps, agitators, and other equipment including spare parts lists, procedures, and treatment programs. Including step by step instructions on test procedures including target concentrations. Contractor to integrate OFCI and OFOI into Plant O & M data.

1.10 QUALIFICATIONS (OFOI):

- A. Manufacturer: Company specializing in manufacturing the products specified in this Section with minimum ten years documented experience. Company shall have local representatives with water analysis laboratories and full time service personnel.
- B. Installer: Company specializing in performing the work of this section with minimum years documented experience and approved by manufacturer.

1.11 REGULATORY REQUIREMENTS (OFOI, CFCI, OFCI):

- A. Conform to applicable code for addition of non-potable chemicals to building mechanical systems, and to public sewage systems.
- B. Products Requiring Electrical Connection: Listed and classified by UL as suitable for the purpose specified and indicated.

1.12 MAINTENANCE SERVICE (OFOI, OFCI):

- A. WTP to furnish service and maintenance of treatment systems for one year from Date of Substantial Completion.
- B. WTP to provide monthly technical service visits to perform field inspections and make water analysis on site. Detail findings in writing on proper practices, chemical treating requirements, and corrective actions needed. Submit two copies of field service report after each visit.
- C. WTP to provide laboratory and technical assistance services during this maintenance period.
- D. WTP to include 8 hour training course for operating personnel, instructing them on installation, care, maintenance, testing, and operation of water treatment systems. Arrange course at start up of systems.
- E. WTP to provide on site inspections of equipment during scheduled or emergency shutdown to properly evaluate success of water treatment program, and make recommendations in writing based upon these inspections.

1.13 MAINTENANCE MATERIALS (CFCI, OFCI, OFOI):

- A. Provide sufficient chemicals for treatment and testing during warranty period.

PART 2 PRODUCTS

2.1 MANUFACTURERS:

- A. WTP

2.2 MATERIALS (OFCI):

- A. System Cleaner:
  1. Liquid alkaline compound with emulsifying agents and detergents to remove grease and petroleum products.
  2. Biocide; chlorine release agents such as sodium hypochlorite or calcium hypochlorite, or microbiocides such as quarternary ammonia compounds, tributyl tin oxide, methylene bis (thiocyanate), or isothiazolones.

- B. Closed System Treatment (Water):
  - 1. Corrosion inhibitors; boron-nitrite, sodium nitrite and borax, sodium tolyltriazole, low molecular weight polymers.
- C. Steam System Treatment:
  - 1. Sequestering agent to reduce hardness and prevent feedline congestion phosphate.
  - 2. Base to provide alkalinity; hydroxide - caustic.
  - 3. Oxygen scavenger; sodium sulfite or hydrazine.
  - 4. Carbon dioxide neutralizer; volatile amines such as morpholine or cyclohexylamine.
  - 5. Filming amines; USDA, FDA Approved.
- D. Condenser Water System Treatment (Cooling Towers):
  - 1. Sequestering agent to inhibit scaling; phosphonates, sodium polyphosphates, synthetic polymerpolyelectrolytes.
  - 2. Acid to reduce alkalinity and pH; sulfuric acid.
  - 3. Corrosion inhibitor; phosphonate-phosphate, tolyltriazole, or low molecular weight polymers.
  - 4. Biocide chlorine release agents such as stabilized bromine or microbiocides such as isothiazolones, gluteraldehyde.
- 2.3 DRIP FEEDER (OFOI):
  - A. Plastic reservoir with coil of capillary tubing with probe, weight, charging syringe, and clip.
- 2.4 SOLUTION METERING PUMPS, ACID FEED PUMPS (OFOI):
  - A. Positive displacement, diaphragm pump with adjustable flow rate, thermoplastic construction, continuous-duty fully enclosed electric motor and drive, and built-in relief valve. Designed for chemical and acid duty. Provide (1) biocide pump, (1) inhibitor pump and (2) acid pumps.
  - B. Electrical Characteristics:
    - 1. 120 volts, single phase, 60 Hz.
    - 2. Cord and Plug: Provide unit with 6 foot cord and plug for connection to electric wiring system including grounding connector.
- 2.6 SOLUTION TANKS (OFOI):
  - A. 50 gallon capacity, self-supporting, gallon graduated markings; molded fiberglass cover with recess for mounting pump, agitator, and liquid level switch, with secondary containment tank.
- 2.7 ACID FEED PIPING SYSTEM:

- A. Provide and install welded 316L stainless steel piping from CFCI Acid Tank through OFOI feed pumps to dilution through within cooling tower basins.
  - B. Interlock operation of acid feed pump and dilution through solenoid valves to allow injection of acid only on proof of flow over tower fill.
- 2.8 LIQUID LEVEL SWITCH (OFOI):
- A. Polypropylene housing with integrally mounted PVC air trap, receptacles for connection to metering pump, and low level alarm.
  - B. Electrical Characteristics:
    - 1. 5a rated load amperes.
    - 2. 120 volts, single phase, 60 Hz.
- 2.9 CONDUCTIVITYCONTROLLER (OFOI):
- A. Packaged monitor controller with solid state circuiting, five percent accuracy, linear dial adjustment, built-in calibration switch, on-off switch and light, control function light, output to control circuit [and recorder].
  - B. Electrical Characteristics:
    - 1. 5a rated load amperes.
    - 2. 120 volts, single phase, 60 Hz.
- 2.10 CHEMICAL TREATMENT WATER METER (OFOI):
- A. Displacement type cold water meter with sealed, tamper-proof magnetic drive, impulse contact register, single pole, double throw dry contact switch. Mechanical registers on face to provide visual indication at flow totalization. Contact switch to interface with CPAS and with Tower Controllers.
  - B. Electrical Characteristics:
    - 1. 5a rated load amperes.
    - 2. 120 volts, single phase, 60 Hz.
- 2.11 SOLENOID VALVES (OFCI):
- A. Forged brass body globe pattern, normally open or closed as required, general purpose solenoid enclosure, and continuous duty coil.
  - B. Electrical Characteristics:
    - 1. 120 volts, single phase, 60 Hz.
  - C. Installation of valve shall be by Plant Contractor. Installation of wiring to solenoid shall be by vendor.
- 2.12 TIMERS (OFOI):



- A. Electronic timers, infinitely adjustable over full range, 150 second and five minute range, mounted together in cabinet with hands-off-automatic switches and status lights.
- B. Electrical Characteristics:
  - 1. 5a rated load amperes.
  - 2. 120 volts, single phase, 60 Hz.

2.13 TEST EQUIPMENT (OFOI):

- A. Provide white enamel test cabinet with local and fluorescent light, capable of accommodating 4 - 10 ml zeroing titrating burettes and associated reagents.
- B. Provide the following test kits:
  - 1. Alkalinity titration test kit.
  - 2. Chloride titration test kit.
  - 3. Sulphite titration test kit.
  - 4. Total hardness titration test kit.
  - 5. Low phosphate test kit.
  - 6. Conductivity bridge, range 0 - 10,000 microhms.
  - 7. Creosol red pH slide complete with reagent.
  - 8. Portable electronic conductivity meter.
  - 9. High nitrite test kit.

PART 3 EXECUTION

3.1 PREPARATION (CONTRACTOR RESPONSIBILITY):

- A. Systems shall be operational, filled, started, and vented prior to cleaning. Contractor shall use water meter to record capacity in each system.
- B. Place automatic control valves in open position during cleaning.
- C. Verify that electric power is available and of the correct characteristics.
- D. Open Plant Equipment Bypass valves and install temporary spools and hoses to take heat exchangers out of loop during circulation of treated water.

3.2 CLEANING SEQUENCE (CONTRACTOR RESPONSIBILITY):

- A. Description:
  - 1. Systems to be cleaned include:
    - a. Steam.

- b. Chilled water.
- c. Condenser water.
- d. Heating water.

B. Responsibility:

- 1. Contractor shall be fully responsible for cleaning and flushing of systems.
- 2. Contractor shall procure sufficient chemicals from Owner's Chemical Treatment Vendor, and shall coordinate with vendor on all matters related to use of chemicals and cleaning procedure.
- 3. Chemical Treatment vendor shall be available to be on-site throughout cleaning and flushing procedure and shall observe condition prior to start.

C. Initial Fill:

- 1. Circulate for 1 hour minimum or until strainers are clean (using system pumps if possible). Chillers are isolated on both condenser and chilled water sides.
- 2. System filled with make-up water and hydro tested (as many times as required for successful test). Equipment bypass lines and install temporary spools and hoses around head exchanges.

D. Flushing:

- 1. Flush the system until clear by continuous bleed and make up and the iron residual is less than 1ppm. Coordinate with SHAE about water use restrictions and discharge points.
- 2. WTP will monitor iron levels and notify.

E. Cleaning:

- 1. Drain enough water to sewer for cleaner to be added to system.
- 2. Add cleaner WTP #8910 to the system (including chillers, if possible) from drum (using 1-1/2" female threaded tap with ball valve.) Chemical pump will be supplied, will require air supply.
- 3. Recirculate for 24 hours (5-6 fps velocity – using tower pumps)
- 4. Drain cleaner fluid to sewer – system must be drained completely, pH adjust if necessary.

F. WTP Monitoring:

- 1. During clean-up procedure WTP will monitor the amount of 8910 cleaner to the system by monitoring make-up water meters for total system volume.
- 2. WTP will also be responsible for monitoring system's water during clean up procedure.
- 3. During discharge to the sewer system, WTP will ensure pH adjustment of all wastewater effluent to city sewage.

G. Passivation:

1. Fill the system with clean make-up water and Nalprep III or approved equivalent.
2. Adjust/maintain the system pH at 6.5 – 7.5.
3. Maintain the Nalprep III treatment concentration at 470 ppm.
4. Circulate for 48 hours minimum.
5. Drain (or bleed off pH adjust and discharge to sanitary sewer) until inorganic phosphate level is between 5 – 10 ppm using ICW water fill for system make up.

3.3 INSTALLATION:

- A. Install in accordance with manufacturer's instructions.

3.4 CLOSED SYSTEM TREATMENT (CFCI):

- A. Provide one bypass feeder on each system. Install isolating and drain valves and necessary piping. Install around balancing valve downstream of circulating pumps unless indicated otherwise.
- B. Introduce closed system treatment through bypass feeder when required or indicated by test.
- C. Provide 3/4 inch water coupon rack around circulating pumps with space for 12 test specimens.

3.5 CONDENSER WATER SYSTEMS (COOLING TOWERS) (OFOI):

- A. Provide automatic condenser water control systems for inhibitor feed, blowdown and biocide feeds. Inhibitor application shall be meter activated, blowdown shall be conductivity activated, and biocide shall be meter fed with blowdown locked out to ensure biocide retention time.
- B. Control system shall incorporate solid state integrated circuits and digital LED displays, in NEMA-12 steel enclosure. Provide gasketed and lockable door.
- C. Base dissolved solids control on conductivity and include:

1. LED digital readout display (microhm/cm).
  2. Temperature compensated sensor probe adaptable to sample stream manifold.
  3. High, low, normal conductance indicator lights (LED).
  4. High or low conductance alarm light (flash or steady switch), trip points field adjustable. Flash or steady switch shall have silence position.
  5. Illuminated legend shall indicate "ALARM" whenever alarm condition exists.
  6. Hand-off-automatic switch for solenoid bleed valve.
  7. Illuminated legend shall indicate "BLEED" when valve is operated.
  8. Adjustable hysteresis or dead-band (internal).
- D. Base inhibitor feed control on make-up volume and include:
1. Solid state counter (1-15 field selectable).
  2. Solid state timer (adjustable 1/4 to 5 minutes).
  3. Test switch.
  4. Hand-off-automatic switch for chemical pump.
  5. Illuminated legend shall indicate "FEED" when pump is activated.
  6. Solid state lock-out timer (adjustable 1/4 to 3 hours) and indicator light. Lock-out timer shall deactivate the pump and activate alarm circuits.
  7. Panel totalizer (amount of makeup), electro-mechanical type.
- E. Biocide Programmer to Include:
1. 24 hour timer with 14 day skip feature to permit activation any hour of the day.
  2. Precision solid state bleed lock-out timer (0-9 hours) and biocide pump timer (0 - 2-1/4 hours), clock controlled.
  3. Solid state alternator to enable the use of two different formulations.
  4. Digital display of the time of day (24 hours).
  5. LED display of day of week (14 days).
  6. Fast and slow clock set controls (internal).
  7. Battery back-up so clock is not disturbed by power outages, quartz timekeeping accuracy.
  8. Hand-off-automatic switches for biocide pumps.
  9. Illuminated legend shall indicate "BIOCIDE A" or "BIOCIDE B" when pump is activated.

- F. Provide water meter on system make-up, wired to control system.
- G. Provide solution pumps to feed sequestering agent and corrosion inhibitor from solution tank into condenser water supply to tower. Provide agitator as required.
- H. Provide conductivity controller to sample condenser water and operate 1/2 inch solenoid bleed valve and piping to blowdown controller sampler wired to open when condensing water pump is operating.
- I. Introduce biocide to tower by continuous feed with solution pump.
- J. Provide liquid level switch in each solution tank to de-activate solution pump and agitator, and signal mechanical alarm system.
- K. Acid Feed Control. Control tower pH through use of acid feed system. Activate tower feed solenoid only on proof of condenser water flow over tower fill.
- L. Provide 3/4 inch (19 mm) water coupon rack around circulating pumps with space for 12 test specimens.

END OF SECTION

SECTION 15684

CENTRIFUGAL WATER CHILLERS

PART 1 GENERAL

1.1 SECTION INCLUDES:

- A. Description of interface between Contractor and Water Chiller Equipment Supplier.
- B. Chiller installation.
- C. Start Up.
- D. Commissioning.
- E. Training.
- F. O&M Manual.
- G. Warranty.

1.2 RELATED SECTIONS:

- A. Section 15260 - Piping Insulation
- B. Section 15712 - Cooling Tower.
- C. Section 15990 - Testing, Adjusting, and Balancing.
- D. Section 15995 – Mechanical Systems Commissioning.

1.3 REFERENCES:

- A. ARI 550 - Centrifugal or Rotary Water-Chilling Packages.
- B. ASHRAE 15 - Safety Code for Mechanical Refrigeration.
- C. ASME SEC 8 - Boiler and Pressure Vessel Code.
- D. NEMA MG1 - Motors and Generators.

1.4 DESCRIPTION OF INTERFACE BETWEEN CONTRACTOR AND EQUIPMENT SUPPLIER:

- A. This section describes the interface between the Contractor and the Owner's Equipment Supplier for the installation, connection, startup, control and commissioning of the Owner Furnished water chillers.

- B. Equipment, Materials, Components, and Services are Identified as:

- 1. Owner Furnished, Owner Installed (OFOI) if they are to be provided, installed, and warranted under separate contract between the Owner and Water Chiller Equipment Provider.
- 2. Contractor Furnished, Contractor Installed (CFCI) if they are to be provided, installed and warranted under this contract.
- 3. Owner Furnished, Contractor Installed (OFCI) if they are to be furnished by the Water Chiller Equipment Provider for installation or use of the Contractor.
- C. Owner Furnished Water Chiller Equipment to be furnished by Water Chiller Equipment provider.

- 1.5 SUBMITTALS FOR REVIEW (OFCI):
- A. Shop Drawings: Indicate components, assembly, dimensions, weights and loadings, required clearances, and location and size of field connections. Indicate equipment, piping and connections, strainers, and valves required for complete system.
  - C. Product Data: Provide rated capacities, weights, specialties and accessories, electrical requirements and wiring diagrams.
- 1.6 SUBMITTALS FOR INFORMATION (OFCI):
- A. Test Reports and manufacturer's detailed installation instructions.
- 1.7 SUBMITTALS AT PROJECT CLOSEOUT (OFCI):
- A. Operation and Maintenance Data: Include start-up instructions, maintenance data, parts lists, controls, and accessories. Include trouble- shooting guide.
- 1.8 STORAGE (OFOI):
- A. Storage of Material and Equipment: The Equipment Provider shall be fully responsible for protection from the weather, securing protective covering, and maintaining the units at a location on campus for a maximum period of six (6) months following date of arrival, if not timed to coincide with Contractor installation schedule.
- 1.9 INSTALLATION (OFOI: EQUIPMENT PROVIDER):
- A. The equipment will be off loaded and stored on site by the Equipment Provider under the Base Proposal.
  - B. At the time of delivery, the Equipment Provider shall provide the services of a Factory Representative to inspect the unit, off load the unit to an outside location on the campus of the University of New Mexico, and provide proper protection and storage. The Equipment Provider may, at his option, coordinate the delivery and off loading of the units with the Installing Contractor.
  - C. Coordination with Contractor:
    - 1. Equipment Provider shall respond in writing within 72 hours to requests for information from Contractor related to such matters as rigging, setting, piping, wiring and details of controls interface.
    - 2. After the installation of the piping, wiring, etc., by the Contractor, the Equipment Provider shall provide the services of a Factory Trained Technician to insure that the installation is in accordance with the offeror's recommendations. The Technician shall make a written report to the Owner.
- 1.10 INSTALLATION (OFCI: CONTRACTOR):
- A. Contractor shall be responsible for:
    - 1. Coordination and placement of structural and concrete pad size and location to accept chiller and starter. Furnish pads and structural supports (includes motor starters).
    - 2. Coordination of anchor bolt and isolation pad location and size. Provide, and install isolation pads and anchor bolts.

3. Coordination of pipe connections for chilled water, condenser water, refrigerant relief. Provide and install flange or victual pipe connectors and pipe.
4. Coordination and placement of wells and taps for chiller control devices such as flow switches, temperature and pressure gauges. Furnish and install taps and wells.
5. Coordination of electrical power and communication connections from plant switchgear to chiller starter, and between chiller starter and chiller unit. Provide and install wire conduit and terminations.
6. Completion of punch list items identified by Equipment Provider, Owner, and/or Commissioning Authority.

1.11 CHILLER START-UP (OFOI):

- A. When so notified by the Contractor through the Owner, the Equipment Provider shall furnish the services of a Factory-Trained Technician to complete leak testing, evacuation, dehydration (using high vacuum pump supplied by offeror) charging and starting the unit. Start-up of each unit shall be completely documented and a signed log and report provided to Owner. Start up shall include the preparation of a punch list and coordination in its resolution with the Installing Contractor.
- B. The qualified technician shall verify proper operation of all motor components, controls and monitoring systems prior to startup. The technician shall record specific motor operating data for relay settings for each unit started.

1.12 CHILLER PLANT COMMISSIONING (OFOI):

- A. Refer to Section 15995 for additional requirements.
- B. Equipment Provider shall be responsible for fully commissioning all chillers and providing a commissioning documentation package to the Owner and Engineer.
  1. Equipment Provider shall assign a chiller commissioning technician who will attend scheduled plant systems commissioning meetings with the Contractor, Owner and Engineer's Commissioning Personnel. Chiller commissioning technician will assist in preparing the plant commissioning plan and schedule including critical path milestones.
  2. Equipment Provider will perform point to point check out of the field installation in the presence of the Owner and Engineer's Commissioning Personnel. All chiller systems will be demonstrated.
  3. Equipment Provider will coordinate with an Independent Testing Agency hired by the Owner, who will document sound, vibration and thermographic baseline properties of each unit. Units not within field sound, vibration and thermographic specifications will be corrected and re-tested by the Equipment Provider at no additional cost to the Owner.
  4. Chiller commissioning technician will assist throughout the commissioning of the Central Plant Automation system. A minimum of 80 hours to be scheduled and coordinated by Engineer's Commissioning Personnel. All modes of operation will be tested and chiller controls sequenced through each. Control or performance issues identified during commissioning process will be documented by the Engineer, and shall be addressed by the Equipment Provider in a timely fashion. A written response shall be required for all issues requiring more than 48 hours to correct.



5. The qualified technician shall verify proper operation of all motor components, controls and monitoring systems prior to startup. The technician shall have specific motor operating data for relay settings for each unit started.
6. The Installing Contractor will be part of the commissioning process to place auxiliary equipment (pumps, fans, etc) in operation, demonstrate successful performance of equipment installed under his contract, and to provide assistance in plant operation during commissioning.

1.13 TRAINING (OFOI):

- A. Factory Trained Representative shall be available at the site to instruct and train the Owners personnel for not less than four (4) days after the Engineer determines the chiller and related systems are operational and fully commissioned. A second two (2) day training session shall be scheduled approximately 60 days after initial start-up. Both training sessions will be scheduled by the Engineer.
- B. The training course must be taught by factory personnel skilled in this type of instruction. The course shall be taught on-site in Albuquerque, and scheduled to accommodate three operational shifts of personnel.
- C. Factory Training shall be provided for two (2) Owner's chiller plant operators. This training, a minimum of 4 days, shall be held at Factory and taught by experienced trainers and include detailed discussion on chiller operation, control, and maintenance. Owner will provide transportation, lodging, and meals.

1.14 OPERATION AND MAINTENANCE MANUAL (OFOI):

- A. Shall be complete, detailed guide for maintenance and operation of the new equipment. It shall include an index covering equipment and accessories, and shall be keyed throughout to the diagrams. The manual shall contain offeror's printed data and shall be sufficiently broad to serve operating staff as a permanent set of instructions upon which they can rely to understand the general theory and concept of the equipment and to assist them in making operating and maintenance adjustments.
- B. Operation and maintenance manuals shall include, but not be limited to, the following information, specific to the particular unit supplied:
  1. Specific Design and Operating Parameters - Performance Data.
  2. Model Numbers and Serial Numbers.
  3. Equipment function, normal operating characteristics, and all limiting conditions. This information shall include all electrical equipment operating and coordination information.
  4. Assembly, installation, alignment, adjustment, and checking instructions.
  5. Lubrication and maintenance instructions.
  6. Complete, detailed "cold start" procedures.
  7. Guide to trouble-shooting.
  8. Parts list and predicted life of parts subject to wear.

9. Outline, cross section, and assembly drawings, engineering data, schematics and wiring diagrams.
  10. Test data and performance curves under variable flow conditions.
  11. Modes of operation for the chilled water system for a minimum load to a maximum load as well as provisions for operation under adverse conditions (component failure of pumps, cooling tower, fans, evaporator/condenser sections, etc.).
  12. Chiller Computer Simulations for full and part load conditions from 10% through 90% at 10% intervals.
  13. Statement of minimum and maximum evaporator flow and tube velocity, special tools required for disassembly/assembly and estimate of annual man-hours required for preventative maintenance.
- C. The operation and maintenance manuals shall be in addition to any instructions or parts lists packed with or attached to the equipment when delivered.
  - D. Manuals and other data shall be printed on heavy, first quality paper, 8-1/2 inches by 11 inches size with standard three-hole punching. Drawings and diagrams shall be reduced to 8-1/2 by 11 inches or 11 inches by 17 inches. Where reduction is not practicable, larger drawings shall be folded separately and placed in envelopes which are bound into the manuals. Each envelope shall bear suitable identification on the outside.
  - E. Submit 12 copies of manuals, and 2 copies of an electronic version on CD Rom.

1.15 WARRANTY:

- A. Owner furnished equipment furnished under this section of the specifications including motors and electrical gear shall be guaranteed by the equipment provider against defective workmanship and material for a period of two (2) years from start date of warranty. Warranty shall include labor, material and refrigerant. All requests for service by the Owner under the warranty provisions must be responded to within 8 hours. In addition, for the period of the warranty, replacement refrigerant and the labor to charge the machine with this refrigerant, for any losses due to defects in material and workmanship, shall be furnished with no additional cost to the Owner.
- B. The start date for the warranty shall be the date of final acceptance of the complete operating unit. Acceptance shall be defined as the time when commissioning of the chiller plant is complete and the Owner has approved the final commissioning report.
- C. Warranty shall include biannual inspection of chiller plant and units by factory representative. Inspection shall include review of Owner supplied operational data and written report stating observations and recommendations applicable to the warranty.

Additionally, equipment provider shall perform eddy current tests of all tube bundles 22 months after unit is placed into operation.

- D. Offeror shall include a Certificate of Warranty stating compliance with this specification prior to delivery. The certificate shall be signed by the factory-authorized service manager in the installing territory. At start-up, a copy of this specification and Certificate of Warranty shall be permanently affixed to the machine control panel in a waterproof envelope. Name, address, and telephone number of the service branch shall be included. It shall be the responsibility of the service branch to contact the Owner in order to schedule major

disassembly work. Failure to notify the Owner shall not relieve the offeror of this Warranty obligation.

## PART 2 PRODUCTS

### 2.1 WATER COOLED WATER CHILLERS:

- A. Electric water cooled water chillers are Trane Model CDHF 2000, 4160V, R123. Absorption chiller is Trane model ABSD1350, 480V.
- B. Complete equipment supplier proposal and post award submittal data for water chillers and starters is on file with Owner.
- C. Design Duty:

#### CH1-3 Electrical Driven Centrifugal

TONS	1975T	
CHW	3000 GPM	58/42
CW	5000 GPM	81/70

#### CH4 Single Effect Steam Absorption

TONS	1350T	
CHW	2400 GPM	59.5/45
CW	2800 GPM	99.5

## PART 3 EXECUTION

### 3.1 INSTALLATION (CONTRACTOR):

- A. Contractor to install in accordance with equipment providers instructions.
- B. Provide for connection to electrical service. Refer to Section 16180.
- C. Provide for connection of electrical wiring between starter and chiller control panel, oil pump, and purge unit.
- D. Align chiller on concrete foundations, sole plates, and sub-bases. Level, grout, and bolt in place.
- E. Install units on vibration isolation.
- F. Provide evaporator connections to chilled water piping.
  - 1. On inlet, provide:
    - a. Thermometer well for temperature controller.
    - b. Thermometer well and thermometer.
    - c. Nipple and flow switch.
    - d. Pressure gage.
    - e. Shut-off valve.
  - 2. On outlet, provide:
    - a. Thermometer well and thermometer.

- b. Pressure gage.
  - c. Discharge valve.
  - d. Part for flow meter.
- G. Insulate evaporator and cold surfaces. Refer to Section 15260.
- H. Provide condenser connection to condenser water piping.
  - 1. On inlet, provide:
    - a. Thermometer well for temperature controller.
    - b. Thermometer well and thermometer.
    - c. Nipple and flow switch.
    - d. Pressure gage.
    - e. Shut-off valve.
  - 2. On outlet, provide:
    - a. Thermometer well and thermometer.
    - b. Pressure gage.
    - c. Discharge valve.
    - d. Port for flow meter.
- I. Provide refrigerant alarm system as indicated on drawings, and specified in Section 15.
- J. Provide piping from chiller rupture disc to refrigerant relief pipe system.
- 3.2 STARTUP (CONTRACTOR):
  - A. Section 15545 – Chemical Water Treatment – Cleaning and Flushing.
  - B. Assist Equipment Provider factory trained representative to leak test, refrigerant pressure test, evacuate, dehydrate, charge, start-up, calibrate controls, and instruct Owner on operation and maintenance.
- 3.3 COMMISSIONING (CONTRACTOR):
  - A. Assist in chiller unit commissioning as required by Sections 15995.
  - B. Commissioning Services shall be in accordance with Section 15995 and shall include:
    - 1. Completion of Pre-functional Checklists as developed by Commissioning Agent.
    - 2. Participation in Functional Performance testing including:
      - a. Flow and Pressure Testing
      - b. Thermal Testing
      - c. Compressor and Motor Vibration and Thermographic Testing
      - d. Pump Speed Control and VFD Testing
      - e. Automatic Valve Testing
      - f. Safety Interlock Testing

- g. Cooling Tower Testing
- h. Plant Sequence and Control Testing
- 5. Take corrective actions necessary to resolve deficiencies uncovered in the commissioning process. Work to be completed within schedule established by the Commissioning Agent.
- 6. Provide complete supporting documentation, including:
  - a. Submittal and engineering data.
  - b. Operation and maintenance data.
  - c. Spare parts data.
  - d. As-Built installation drawings

Final documentation package to be as described in Section 15995

END OF SECTION

SECTION 15712  
COOLING TOWERS

PART 1 GENERAL

1.1 SECTION INCLUDES:

- A. Description of interface between Contractor and Cooling Tower Equipment Supplier.
- B. Component installation.
- C. Contractor use of premises.
- D. Storage of materials.
- E. Start up.
- F. Commissioning.
- G. Training.
- H. O & M Manual.
- I. Warranty.

1.2 RELATED SECTIONS:

- A. Section 15260 - Piping Insulation
- B. Section 15990 - Testing, Adjusting, and Balancing.

1.3 REFERENCES:

- A. NEMA MG1 - Motors and Generators.

1.4 DESCRIPTION OF INTERFACE BETWEEN CONTRACTOR AND EQUIPMENT SUPPLIER:

- A. This section describes the interface between the Contractor and the Owner's Equipment Supplier for the installation, connection, startup, control and commissioning of the Owner Furnished cooling tower components.
- B. Equipment, Materials, Components, and Services are Identified as:
  - 1. Owner Furnished, Owner Installed (OFOI) if they are to be provided, installed, and warranted under separate contract between the Owner and Cooling Tower Equipment Provider.
  - 2. Contractor Furnished, Contractor Installed (CFCI) if they are to be provided, installed and warranted under this contract for the Lomas Chilled Water Plant.
  - 3. Owner Furnished, Contractor Installed (OFCI) if they are to be furnished by the Cooling Tower Equipment Provider for installation or use of the Lomas Chilled Water Plant Contractor.

1.5 SUBMITTALS FOR REVIEW (OFOI):

- A. Shop Drawings: Cooling Tower Equipment Vendor to indicate components, assembly, dimensions, weights and loadings, required clearances, and location and size of field connections. Indicate equipment, piping and connections, strainers, and valves required for complete system. Cooling Tower Equipment Vendor to provide support and interface details to Contractor for such items as fill support beams, riser clamp anchors, drift eliminator support clips, etc.

- B. Product Data: Cooling Tower Equipment Vendor to provide rated capacities, weights, specialties and accessories, electrical requirements and wiring diagrams.
- 1.6 SUBMITTALS FOR INFORMATION (OFCI):
- A. Cooling Tower Equipment Vendor to submit manufacturer's detailed installation instructions.
- 1.7 SUBMITTALS AT PROJECT CLOSEOUT (OFCI):
- A. Operation and Maintenance Data: Include start-up instructions, maintenance data, parts lists, controls, and accessories. Include trouble-shooting guide.
- 1.8 STORAGE (OFOI):
- A. Storage of Material and Equipment: The Equipment Provider shall be fully responsible for protection from the weather, securing protective covering, and maintaining the units at a storage location on campus for a maximum period of six (6) months following date of arrival.
  - B. The Contractor shall provide adequate laydown and staging area during installation of components.
- 1.9 INSTALLATION (OFOI: EQUIPMENT PROVIDER):
- A. The equipment will be off loaded and stored at a location on campus by the Equipment Provider under the Base Proposal.
  - B. At the time of delivery, the Equipment Provider shall provide the services of a Factory Representative to inspect the unit, off load the unit to an outside location on the campus of the University of New Mexico, and provide proper protection and storage. The Equipment Provider may, at his option, coordinate the delivery and off loading of the units with the Installing Contractor, and component installation phasing to minimize handling of material.
  - C. Coordination with Contractor:
    - 1. Equipment Provider shall respond in writing within 48 hours to requests for information from Contractor related to such matters as imbed location and details, rigging, setting, piping, wiring and details of controls interface.
    - 2. After the installation of the piping, wiring, etc., by the Contractor, the Equipment Provider shall provide the services of a Factory Trained Technician to insure that the installation is in accordance with the offeror's recommendations. The Technician shall make a written report to the Owner.
- 1.10 INSTALLATION (OFCI: CONTRACTOR):
- A. Contractor shall be responsible for:
    - 1. Coordination and placement of the size and location of structural concrete slabs, walls, beams, etc. to accept. Provide pads, attachment points, and structural supports.
    - 2. Coordination of anchor bolt and pad location and size. Provide pads and anchor bolts.
    - 3. Coordination of pipe connections for condenser water. Provide flange pipe connectors and pipe.

4. Coordination and placement of wells and taps for chiller plant control devices such as flow switches, pressure gauges, and safety switches. Furnish and install taps and wells.
5. Coordination of electrical power and communication connections from plant switchgear to motor starters to motors starter. Provide wire conduit and terminations.
6. Completion of punch list items identified by Equipment Provider, Owner, and/or Commissioning Authority.

1.11 INSTALLATION (CFCI: COOLING TOWER EQUIPMENT SUPPLIER):

A. Cooling Tower Equipment Supplier shall be responsible for:

1. Design fabrication and installation of cooling tower internal components including, but not limited to:
  - a. Intermediate fill support beams (FRP).
  - b. Fill and fill supports.
  - c. Distribution piping including bypass pipe from fan deck elevation down.
  - d. Drift eliminators and drift eliminator supports.
  - e. Access ways, ladders and catwalks.
  - f. Fans, drives, transmissions, and motors.
  - g. Fan shrouds and screen.
  - h. Splash out diverters.
  - i. Wind walls.
2. Start up and commissioning.
3. Training.
4. Warranty.
5. O & M Manual.

1.12 COOLING TOWER START-UP (OFOI):

- A. When so notified by the Owner, the Equipment Provider shall furnish the services of a Factory-Trained Technician to test, adjust, and start the unit. Start-up of each unit shall be completely documented and a signed log and report provided to Owner. Start up shall include the preparation of a punch list and coordination in its resolution with the Installing Contractor.
- B. The qualified technician shall verify proper operation of all motor components, controls, safety interlocks, and monitoring systems prior to startup. The technician shall record specific motor operating data for relay settings for each unit started.

1.13 CHILLER PLANT COMMISSIONING (OFOI):

- A. Refer to Section 15995 for additional requirements.
- B. Equipment Provider shall be responsible for fully commissioning all cooling towers and providing a commissioning documentation package to the Owner and Engineer.
  1. Equipment Provider shall assign a commissioning technician who will attend scheduled plant systems commissioning meetings with the Contractor, Owner and Engineer's



Commissioning Personnel. Commissioning technician will assist in preparing the plant commissioning plan and schedule including critical path milestones.

2. Equipment Provider will perform point to point check out of the field installation in the presence of the Owner and Engineer's Commissioning Personnel. All cooling tower systems will be demonstrated.
3. Equipment Provider will coordinate with an Independent Testing Agency hired by the Owner, who will document sound, vibration and thermographic baseline properties of each unit. Units not within field sound, vibration and thermographic specifications will be corrected and re-tested by the Equipment Provider at no additional cost to the Owner.
4. Chiller commissioning technician will assist throughout the commissioning of the Central Plant Automation system. A minimum of 20 hours to be scheduled and coordinated by Engineer's Commissioning Personnel. All modes of operation will be tested and controls sequenced through each. Control or performance issues identified during commissioning process will be documented by the Engineer, and shall be addressed by the Equipment Provider in a timely fashion. A written response shall be required for all issues requiring more than 48 hours to correct.
5. The qualified technician shall verify proper operation of all motor components, controls and monitoring systems prior to startup. The technician shall have specific motor operating data for relay settings for each unit started.
6. The Installing Contractor will be part of the commissioning process to demonstrate successful performance of equipment installed under his contract, and to provide assistance in plant operation during commissioning. The Equipment Provider shall be responsible for coordination of efforts with the Contractor.

1.14 TRAINING (OFOI):

- A. Factory Trained Representative shall be available at the site to instruct and train the Owners personnel for not less than two (2) days after the Engineer determines the chiller and related systems are operational and fully commissioned. A second two (2) day training session shall be scheduled approximately 60 days after initial start-up. Both training sessions will be scheduled by the Engineer.
- B. The training course must be taught by factory personnel skilled in this type of instruction. The course shall be taught on-site in Albuquerque, and scheduled to accommodate three operational shifts of personnel.

1.15 OPERATION AND MAINTENANCE MANUAL (OFOI):

- A. Shall be complete, detailed guide for maintenance and operation of the new equipment. It shall include an index covering equipment and accessories, and shall be keyed throughout to the diagrams. The manual shall contain offeror's printed data and shall be sufficiently broad to serve operating staff as a permanent set of instructions upon which they can rely to understand the general theory and concept of the equipment and to assist them in making operating and maintenance adjustments.
- B. Operation and maintenance manuals shall include, but not be limited to, the following information, specific to the particular unit supplied:
  1. Specific Design and Operating Parameters - Performance Data.
  2. Model Numbers and Serial Numbers.

3. Equipment function, normal operating characteristics, and all limiting conditions. This information shall include all electrical equipment operating and coordination information.
  4. Assembly, installation, alignment, adjustment, and checking instructions.
  5. Lubrication and maintenance instructions.
  6. Complete, detailed "cold start" procedures.
  7. Guide to trouble-shooting.
  8. Parts list and predicted life of parts subject to wear.
  9. Outline, cross section, and assembly drawings, engineering data, schematics and wiring diagrams.
  10. Test data and performance curves under variable flow conditions.
  11. Modes of operation for the cooling tower water system for a minimum load to a maximum load as well as provisions for operation under adverse conditions (component failure of pumps, fans, etc.).
  12. Chiller Computer Simulations for full and part load conditions from 50% through 90% at 10% intervals.
  13. Statement of minimum and maximum distribution system flow and velocity, special tools required for disassembly/assembly and estimate of annual man-hours required for preventative maintenance.
- C. The operation and maintenance manuals shall be in addition to any instructions or parts lists packed with or attached to the equipment when delivered.
- D. Manuals and other data shall be printed on heavy, first quality paper, 8-1/2 inches by 11 inches size with standard three-hole punching. Drawings and diagrams shall be reduced to 8-1/2 by 11 inches or 11 inches by 17 inches. Where reduction is not practicable, larger drawings shall be folded separately and placed in envelopes which are bound into the manuals. Each envelope shall bear suitable identification on the outside.
- E. Submit 12 copies of manuals, and 2 copies of an electronic version on CD Rom.

1.16 WARRANTY:

- A. All equipment furnished under this section of the specifications including motors and electrical gear shall be guaranteed by the Equipment Provider against defective workmanship and material for a period of two (2) years from start date of warranty. Warranty shall include labor and material. All requests for service by the Owner under the warranty provisions must be responded to within 8 hours.
- B. The start date for the warranty shall be the date of final acceptance of the complete operating unit. Acceptance shall be defined as the time when commissioning of the chiller plant is complete and the Owner has approved the final commissioning report.
- C. Warranty shall include biannual inspection of chiller plant and cooling tower by factory representative. Inspection shall include review of Owner supplied operational data and written report stating observations and recommendations applicable to the warranty.

- D. Offeror shall include a Certificate of Warranty stating compliance with this specification prior to delivery. The certificate shall be signed by the factory-authorized service manager in the installing territory. At start-up, a copy of this specification and Certificate of Warranty shall be permanently affixed to the machine control panel in a waterproof envelope. Name, address, and telephone number of the service branch shall be included. It shall be the responsibility of the service branch to contact the Owner in order to schedule major disassembly work. Failure to notify the Owner shall not relieve the offeror of this Warranty obligation.

## PART 2 PRODUCTS

### 2.1 INDUCED DRAFT COOLING TOWERS:

#### A. Design Duty:

1. Maximum Duty: 5000 gpm from 80.5° to 70°F with 64°F entering wet bulb.
2. Economizer Duty: 3000 gpm form 48°F to 42°F with 36°F entering wet bulb.

## PART 3 EXECUTION

### 3.1 INSTALLATION (CONTRACTOR):

- A. Contractor to install in accordance with equipment providers instructions.
- B. Provide for connection to electrical service. Refer to Section 16180.
- C. Provide for connection of electrical wiring between starter and fan, oil safety switch, and vibration switch.
- D. Install imbeds and anchors coordinated to accept installation of cooling tower components by equipment supplier.
- E. Provide connections to condenser piping.

### 3.2 STARTUP (CONTRACTOR):

- A. Section 15545 – Chemical Water Treatment – Cleaning and Flushing.
- C. Assist Equipment Provider factory trained representative to test, start-up, calibrate controls, and instruct Owner on operation and maintenance.

### 3.3 COMMISSIONING (CONTRACTOR):

- A. Assist in cooling tower commissioning as required by Sections 15995.
- B. Commissioning Services shall be in accordance with Section 15995 and shall include:
  1. Completion of Pre-functional Checklists as developed by Commissioning Agent.
  2. Participation in Functional Performance testing including:
    - a. Flow and Pressure Testing
    - b. Thermal Testing
    - c. Fan Motor Vibration and Thermographic Testing
    - d. Pump Speed Control and VFD Testing

- e. Automatic Valve Testing
  - f. Safety Interlock Testing
  - g. Chiller Tower Testing
  - h. Plant Sequence and Control Testing
3. Take corrective actions necessary to resolve deficiencies uncovered in the commissioning process. Work to be completed within schedule established by the Commissioning Agent.
4. Provide complete supporting documentation, including:
- a. Submittal and engineering data.
  - b. Operation and maintenance data.
  - c. Spare parts data.
  - d. As-Built installation drawings

Final documentation package to be as described in Section 15995 and 17100

END OF SECTION

## SECTION 15910

### IDENTIFICATION

#### PART 1 GENERAL

##### 1.1 DESCRIPTION OF WORK:

- A. Identification of pipe, equipment, controls and auxiliaries within plant.

##### 1.2 RELATED WORK:

- A. Section 15010 – Mechanical General Provisions
- B. Section 15060 – Utility Plant Piping and Valves
- C. Section 15100 – Valves and Valve Operators

##### 1.3 SUBMITTALS:

- A. Provide submittals for complete identification system for Architect/Engineer and Owner review.

##### 1.4 DEFINITIONS:

- A. Piping Systems: For the purpose of this standard, piping systems shall include pipes of any kind and, in addition, fittings, valves, and pipe coverings. Supports, brackets, or other accessories are specifically excluded from applications of this standard. Pipes are defined as conduits for the transport of gases, liquids, or semiliquids.
- B. American National Standards Institute (ANSI):
  - 1. A13.1 – Identification of Piping Systems
  - 2. Z53.1 – Safety Color Code for Marking Physical Hazards

#### PART 2 PRODUCTS

##### 2.1 PAINT FOR IDENTIFICATION AND FOR PIPING:

- A. In finished areas, all uninsulated, exposed piping, except galvanized, copper or cast iron drainage piping, shall be cleaned and painted with two coats of oil base paint provided that the surface temperature will not exceed 120°F; a high temperature paint shall be used where surface temperatures exceed 120°F.
- B. Do not paint nameplates, labels, tags, stainless steel sprinkler heads, valve stems, equipment shafts, packing glands, lubrication fittings, or chromium-plated items as levers, handles, trim strips or similar items.
- C. All ferrous metal work exposed to the weather and not factory-enameled shall be painted with one coat red lead and two coats of lead and oil paint.
- D. Surface finishes in hazardous areas similar to mechanical equipment rooms, storage rooms, and exit passageways shall be rated in accordance with ANSI A2.5 (ASTM E84 or NFPA 225 or UL 723) standard for flame spread of less than 25 and smoke developed less than 50.

##### 2.2 ACCEPTABLE MANUFACTURERS FOR COLOR CODED BANDING:

- A. EMED Company, 330 Green Street, Box 369, Buffalo, NY 14240.
- B. Seton Name Plate Corporation, New Haven, CT 06505.
- C. W.H. Brady Company, Signmark Division, 727 W. Glendale Avenue, P.O. Box 571, Milwaukee, WI 53201.
- D. National Marker Company, P.O. Box 1659, Pawtucket, RI 06862.
- E. R.K. Industries, 1501 Virginia Avenue, Baldwin Park, CA 91706.
- F. Carlton Industries, Inc., P.O. Box 280, LaGrange, TX 78945.

### 2.3 MECHANICAL SYSTEM COLOR IDENTIFICATION:

- A. Use markers with a green color field and white lettering to identify liquids or liquid admixtures of inherently low hazard, including:
  - 1. Chilled water
  - 2. Condenser water
  - 3. Service water
- B. Use markers with a blue color field and white lettering to identify gasses or gaseous admixtures of inherently low hazard, including:
  - 1. Compressed air
- C. Use appropriate markers for all systems including, but not limited to:
  - 1. 15 psi steam
  - 2. 125 psi steam
  - 3. Pumped condensate
  - 4. Gravity condensate
  - 5. Refrigerant relief
  - 6. Sulfuric acid

## PART 3 EXECUTION

### 3.1 INSTALLATION:

- A. Placement – Provide Identification Markers:
  - 1. On all exposed, covered, and uncovered pipes at 20 foot intervals.
  - 2. On all branches and valves.
  - 3. On both sides of walls where pipes pass through wall.
  - 4. Where pipes pass through floor.
  - 5. At changes of flow direction.
  - 6. At all equipment.

### 3.2 TYPE AND SIZE OF LETTERS:

- A. Contrast shall be provided between color field and legend for readability. On overhead piping, stencil legends on the lower quarter of the pipe where a view from the floor is unobstructed. Use of letters of standard style, in sizes 1/2" (13 mm) and larger, is recommended. Refer to Table of Sizes (below) for specific size recommendations. For identification of materials in pipes of less than 3/4" (19 mm) in diameter, and for valve and fitting identification, the use of a permanently legible tag is recommended. Stencil an arrow marker at each identification marker, with arrow pointed from legend in the direction of flow. If flow may be both ways, stencil double-headed arrows.

OUTSIDE DIAMETER OF PIPE OR				LETTERS	
IN.	MM.	IN.	MM.	IN.	MM.
3/4 TO 1-1/4	19 TO 32	8	200	1/2	13
1-1/2 TO 2	38 TO 51	8	200	3/4	19
2-1/2 TO 6	64 TO 150	12	300	1-1/4	32
8 TO 10	200 TO 250	24	600	2-1/2	64
Over 10	Over 250	32	800	3-1/2	89

3.3 VALVE TAGS AND NUMBERING:

- A. All valves shall be tagged with 1-1/4 " diameter, 0.040" thick brass or laminated plastic tags with numbers and letters. A complete directory of valves, pump motors, controls, devices, and other equipment, giving use, location, size, and manufacturer's number of each shall be prepared with permanent ink, framed under glass, and hung in the mechanical equipment room where directed by the University.

3.4 FLOW INDICATORS:

- A. Stencil an arrow marker at each identification marker, with arrow pointed away from legend in the direction of flow. If flow may be both ways, stencil double-headed arrows with matching colors.

END OF SECTION

## SECTION 15975

### CENTRAL PLANT AUTOMATION SYSTEM

#### PART 1 GENERAL

##### 1.1 SECTION INCLUDES:

- A. Description of interface between Contractor and Central Plant Automation System Equipment Supplier:
- B. Pneumatic system installation and connections
- C. Electrical systems installation and connections
- D. Metering system connections
- E. Refrigerant alarm system connections
- F. Safeties, alarms, and interlocks connections
- G. Integration to third party controls
- H. Communication

##### 1.2 RELATED SECTIONS:

- A. Section 15010 – Mechanical General Provisions
- B. Section 15050 – Utility Plant Piping Specialties
- C. Section 15680 – Cooling Towers
- D. Section 15684 – Water Chillers
- E. Section 15995 – Mechanical Systems Commissioning
- F. Section 16155 – Motor Starters
- G. Section 16363 – Medium Voltage Metal Clad Switchgear
- H. Section 16462 – Distribution Switchboards
- I. Section 16920 – Motor Control Centers
- J. Section 16925 – Variable Frequency Drive Motor Controller

##### 1.3 REFERENCES:

- A. ASME MC85.1 – Terminology for Automatic Control
- B. NEMA 250 – Enclosures for Electrical Equipment (1000 Volts Maximum)
- C. NEMA EMC1 – Energy Management Systems Definitions
- D. NFPA 90A – Installation of Air Conditioning and Ventilation Systems
- E. NFPA 70 – National Electrical Code

##### 1.4 Deleted

##### 1.5 CENTRAL PLANT AUTOMATION SYSTEM DESCRIPTION:

- A. In general, the CPAS supplier is responsible for engineering, selection and provision of control components, preparation of point-to-point wiring diagrams, mounting of primary control cabinets, supervision of terminations, point-to-point checkout, startup, programming, and commissioning of the Central Plant Automation System. Details of the pneumatic system are shown on the drawings.
- B. The Contractor is responsible for providing and installing the pneumatic valves, activators and piping and electrical wire, conduit, and conduit support systems necessary to complete the installation, and as well as connection to metering and equipment control devices as indicated in the documents and in accordance with Divisions 16 of these documents. Details of the electrical systems and interfaces are shown in an attached document prepared by Southwest Trane.



- C. Integration of the CPAS system with Contractor furnished devices (such as variable frequency drive motor controllers, meters, electrical relays, and packaged unit mounted controls) is the joint responsibility of the CPAS supplier and the Contractor. Details of these interfaces are shown on the drawings and on the attached document prepared by Southwest Trane.
  - D. The Contractor is responsible for overall coordination of the CPAS system with the work of the various trades.
- 1.6 SUBMITTALS FOR REVIEW (OFOI):
- A. Product Data: CPAS supplier to provide description and engineering data for each control system component.
  - B. Shop Drawings: CPAS supplier to indicate complete operating data, system drawings, wiring diagrams, and written detailed operational description of sequences.
- 1.7 SUBMITTALS FOR REVIEW (CONTRACTOR):
- A. Refer to Section 16050 - Basic Electrical Methods and Requirements for submittals related to installation of electrical systems.
  - B. Refer to Section 15010 – Mechanical General Provisions for submittals relating to installation of mechanical systems.
- 1.8 SUBMITTALS AT PROJECT CLOSEOUT (CONTRACTOR):
- A. Project Record Documents: Record actual locations of control components, including panels wireways, tubing, meters, interlocks, and sensors. Revise shop drawings to reflect actual installation and operating sequences.
  - B. Integrate CPAS materials into project O & M Manual.
- 1.9 QUALITY ASSURANCE (OF CI, CFCI):
- A. Installer Qualifications: Company specializing in performing the work of this section with minimum ten (10) years documented experience.
  - B. Design and install details of system under direct supervision of CPAS Engineer.
- 1.10 REGULATORY REQUIREMENTS (OF CI, OFOI, CFCI):
- A. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories, Inc., as suitable for the purpose specified and indicated.
- 1.11 PREINSTALLATION MEETING (OF CI, OFOI, OFCI):
- A. Section 01039 – Coordination and Meetings: Preinstallation meeting.
  - B. Convene six (6) weeks before starting work of this section.
- 1.12 COORDINATION:
- A. Contractor shall be responsible for overall coordination of CPAS with plant work.
  - B. Specific areas of coordination include:
    - 1. Pneumatic control systems

2. Electrical power and communication systems
  3. Metering systems
  4. Connection to third party devices such as variable frequency drive motor controllers, unit mounted controls, and electrical interlocks, safeties and alarms.
- C. Contractor's Responsibilities include:
1. Timely response to Requests for Information for:
    - a. Component descriptions and cut sheets
    - b. Device locations
    - c. Scheduled installation startup and commissioning dates
    - d. Installation means and methods
  2. Integration of CPAS into project schedule and adjustment as required.
  3. Installation of materials and equipment as specified.
  4. Use of facilities by CPAS vendor during construction.
  5. Storage of materials.
  6. Assistance during startup of equipment including activation and deactivation of components and systems.
  7. Participation in Systems Commissioning.

## PART 2 PRODUCTS

### 2.1 INTERFACE BETWEEN CPAS AND CONTRACTOR:

- A. Pneumatic Control Compressor and Piping: Furnished, installed, hydrostatically tested, started up and warranted by Contractor, accepted by CPAS and Owner.
- B. Pneumatic Devices (Valve Actuators): Furnished, installed, checked out, started up and warranted by Contractor, accepted by CPAS and Owner.
- C. Electrical Power and Communication Systems: Furnished, installed, checked out, started up and warranted by Contractor, accepted by CPAS and Owner.
- D. Integration With Third Party Devices Such as Variable Frequency Drive Motor Controllers, Packaged Unit Mounted Controls, Meters, etc.: Furnished, installed, checked out, started up and warranted by Contractor, accepted by CPAS and Owner.
- E. Safeties, Alarms, Interlocks: Furnished, installed, checked out and warranted by Contractor Water Chiller, Water Treatment or Cooling Tower equipment supplier, accepted by CPAS and Owner.
- F. Refrigerant Alarm System: Furnished, installed, checked out and warranted by Contractor, accepted by CPAS and Owner. Refer to Section 15120.

### 2.2 CPAS SCOPE DESCRIPTION:

- A. Overall CPAS scope description and post award shop drawings are on file and available from

Owner.

PART 3 EXECUTION

3.1 INSTALLATION:

- A. Installation of CPAS Pneumatic Systems by Contractor shall be in strict accordance with Division 15 of these specifications.
- B. Installation of CPAS Electrical Systems by Contractor shall be in strict accordance with Division 16 of these specifications.

END OF SECTION

## SECTION 15990

### TESTING, ADJUSTING AND BALANCING

#### PART 1 GENERAL

##### 1.1 SUMMARY:

###### A. Section Includes:

1. Contractor qualification requirements.
2. Required submittals.
3. Test and Balance of systems.
4. Chilled water pump operational tests.
5. Chiller evaporator and condenser operational tests.
6. Heat exchanger operational tests.
7. Condenser water pump operational tests.

###### B. Related Sections:

1. Section 01300: Submittals
2. Section 15995: Mechanical Systems Commissioning

##### 1.2 QUALITY ASSURANCE:

- A. Contractor shall provide the services of an independent test and balance organization which specializes in testing and balancing of heating, ventilating, and air conditioning systems, to balance, adjust, and test air and water moving equipment and systems. Submit to Architect/Engineer qualifications of test and balance organization for approval. Test and balance organization shall be AABC or NEBB certified and shall provide proof of having successfully completed at least three projects of similar size and scope. The Contractor shall submit the specific qualifications of the lead site technician who will remain on site during all TAB work within 60 days of Notice to Proceed. The Owner shall approve in writing the qualifications of both the company and lead technician. Instruments shall be accurately calibrated and maintained in good working order during the life of testing procedures. Tests shall be conducted in the presence of Architect/Engineer when required. Demonstrate compliance with contract when requested by Architect/Engineer.
- B. Allot sufficient time in construction schedule for test and balance completion.
- C. Final testing and balancing shall be conducted after system has been completed and in full working order. Contractor shall put all equipment into full operation and shall continue operation of same during each working day of testing and balancing.
- D. Procedure and test shall be as specified. Procedure and test not specified shall be in accordance with Associated Air Balance Council publication, "National Standards for Field Measurements and Instrumentation, Total System Balance" or comply with the applicable procedures in the chapter on Testing, Adjusting and Balancing in the latest ASHRAE Edition of the Systems Handbook.
- E. Calibration and maintenance of instruments shall be in accordance with manufacturer's standards and recommendations, and calibration histories for each instrument shall be available for examination.
- F. Accuracy of measurements shall be in accordance with the applicable measurement means as

listed in the chapter on Measurement and Instruments in the latest edition of ASHRAE Fundamentals Handbook.

- G. Allowable Tolerances:
  - 1. Tolerances of adjustment for air handling systems are plus or minus 5% for supply systems and plus or minus 10% for return and exhaust systems from figures shown on drawings.
  - 2. Tolerances of adjustment for hydronic systems, are plus or minus 10% of design conditions shown on drawings.
- H. Equipment:
  - 1. Ultrasonic flow meter equal to Polysonics.
  - 2. Compound gage with accuracy of plus or minus 5% and calibration certificate current within four months.
- I. Final Testing, Adjusting and Balancing of all hydronic and air systems shall be performed by an acceptable separate professional Testing, Adjusting and Balancing subcontractor meeting the above Quality Assurance requirements.
- J. Within 30 days after execution of the Owner-Contractor Agreement, transmit to Architect/Engineer the name and qualifications of the organization proposed to perform the services.
- K. TAB Contractor shall review Design Drawings prior to completion of pipe and ductwork and provide written recommendations for additional ports and test wells.

### 1.3 SUBMITTALS

- A. Procedure: Submit Qualifications, Documentation, Test Schedules and Reports.
- B. Qualifications:
  - 1. Submit three copies of documentation to confirm compliance with Quality Assurance provisions:
    - a. Organization supervisor and personnel training and qualifications.
    - b. Specimen copy of each of the report forms proposed for use.
- C. Preliminary Report: At least fifteen days prior to starting field work, submit three copies of:
  - 1. A set of report forms filled out as required as to the design flow values and the installed equipment pressure drops, and the required CFM for air terminals.
  - 2. A complete list of instruments proposed to be used, organized in appropriate categories, with data-sheets for each. Show:
    - a. Manufacturer and model number.
    - b. Description and use when needed to further identify the instrument.
    - c. Size of capacity range.
    - d. Latest calibration date.
  - 3. Architect/Engineer will review submittals for compliance with Contract Documents, and

will return one set marked to indicate:

- a. Discrepancies noted between data shown and Contract Documents.
- b. Additional, or more accurate, instruments required.
- c. Requests for re-calibration of specific instruments.

D. Schedules:

1. Schedule tests to comply with project completion schedules.
2. Schedule testing and balancing of parts of the systems which are delayed due to seasonal, climatic, occupancy, or other conditions beyond control of the Contractor, as early as the proper conditions will allow, after consultation with Architect/Engineer.
3. Submit reports of delayed testing promptly after execution of those services.

E. Final Report: At least fifteen days prior to Contractor's request for final inspection, submit three copies of final reports, on applicable reporting forms, for review. Each individual final reporting form must bear the signature of the person who recorded data and that of the Testing, Adjusting and Balancing supervisor of the reporting organization. Identify instruments of all types which were used and last date of calibration of each. Report shall include:

1. A set of reduced black and white or blue-line prints with all air openings clearly marked to correspond with data sheets and with thermometer locations clearly marked.
2. Data sheets showing amount of air handled at each opening, instrument used, velocity readings, and manufacturer free area factor.
3. Equipment data sheets giving make, size and model, of fans, starters and motors with rated amps and service factors, and drives. Include pumps and recirculating fans.
4. Operating data including fan RPM, inlet and outlet pressures, pressure drop across filters, face and bypass dampers, and measured motor current and voltage, BHP and CFM (total).
5. Cooling equipment operating data including air temperatures entering and leaving cooling coils together with corresponding air flow and air pressure drop, water temperature entering and leaving cooling coil, and water flow and pressure drop through cooling coil.
6. Equipment and operating data as required to show performance of pumps, fans, and temperature control devices.
7. Data sheets showing results of:
  - a. Chilled water pump operational tests.
  - b. Secondary pump operational tests.
  - c. Chiller evaporator operational tests.
  - d. Sand filter pump operational tests.
  - e. Heat exchanger operational tests.
  - f. Cooling tower distribution tests.
  - g. Condenser water pump tests.
8. A statement outlining all abnormal or notable conditions not covered in above data.

1.4 PROJECT CONDITIONS

- A. The following job conditions must be verified before any testing, adjusting or balancing of the

systems begin:

1. Installation of the designated system is complete and in full operation.
2. On hydronic systems, strainers shall be cleaned, temperature control valve operation shall be checked, pump rotation shall be checked, and other such conditions requiring correction.
3. Air systems shall be checked for dirty filters, filter and duct leakage, equipment vibrations, damper operation, fan rotation, and other such conditions requiring correction.

## PART 2 PRODUCTS

Not used

## PART 3 EXECUTION

### 3.1 PROCEDURE

- A. Confirm that project conditions have been verified and that necessary corrections have been made before proceeding with the Work.

### 3.2 AIRBALANCE:

- A. Make Pitot Tube traverse of main ducts.
- B. Test and adjust blower RPM to produce design requirements.
- C. Test and record motor full load amperes. Current must not exceed nameplate ratings. Calculate indicated field measured brake horsepower.
- D. Test and record system static pressures, suction and discharge.
- E. Test and adjust system for design recirculated air CFM.
- F. During balancing and testing period, all supply air fans shall have speeds adjusted and drives changed where necessary so that fan delivers design CFM at the actual static pressure developed by the installed system. Increasing static pressure by dampering at fan will not be permitted. All air filters shall be artificially loaded by partial blanking or other means to produce air pressure drop mid-way between clean and dirty as specified.
- G. Test and record entering and leaving air temperatures of each air handling unit.
- H. Test and adjust each register to within plus or minus 10% of design requirements, but total air for each system shall be not less than indicated.
- I. Each register and air handling unit shall be identified on test report as to location and area.
- J. Identify and list size, room number and outlet number of registers and all tested equipment. Manufacturer's ratings and coefficients for all equipment shall be used to make required calculations on reports; state coefficients used. A complete set of 1/2 size reductions of all mechanical floor plans shall be submitted to indicate location and outlet number.
- K. Readings and tests of registers and air handling units shall include required FPM velocity and test resultant velocity, required CFM and test resultant CFM after adjustments.

### 3.3 SECONDARY PUMP OPERATIONAL TEST:

- A. Read flow and pressure differential across secondary loop pump for one and two pumps operating.
- B. Adjust flow rate to design valve using balancing valves.

3.4 CHILLEDWATER PUMPOPERATIONAL TESTS:

- A. Coordinate with VFD installer during commissioning and start up of chilled water pumps to verify calibration and operation of VFD.
- B. Read shut off head, pump suction, and discharge pressures and motor ampacity at each manually set VFD position from 30% to 100% in 10% increments. Use compound gage to verify differential pressure transducer. Record data in the following format:

<u>% Speed</u>	<u>Suction Shut off (psi)</u>	<u>Discharge (psi)</u>	<u>BAS (psi)</u>	<u>Test dP</u>	<u>dP</u>
30					
40					
50					
60					
70					
80					
90					
100					

Plot operating points for each pump on clean copy of pump curve minimum 8-1/2" x 11" size.

3.5 CHILLER CONDENSOR ANDEVAPORATOR OPERATIONAL TESTS:

- A. Test flow vs. pressure drop relationship of chiller evaporators and condensors.
- B. Read flow through each chiller evaporator and condensor with ultrasonic flowmeter. Record data in 10% increments from 50% to 100% of rated flow. Use compound gage to verify differential pressure transducer. Adjust flow rate using chiller discharge valves. Record data in the following format:

<u>% Flow</u>	<u>Flow (gpm)</u>	<u>Inlet (psi)</u>	<u>Outlet (psi)</u>	<u>CPAS dP</u>	<u>Test dP</u>	<u>CPAS Flowmeter GPM</u>
30						
40						
50						
60						
70						
80						
90						
100						

Work with Engineer to develop least squares polynomial fit for each chiller of BAS dP vs. ultrasonic flow for use in BAS. This will require (3) meetings with Engineer and one retest.

3.6 HEATEXCHANGER OPERATIONAL TESTS:

- A. Test heat exchangers.



- B. Using compound gage, verify differential pressure gage across both sides of both heat exchangers.
- C. Record shut-off head, operating suction and discharge pressure for each pump alone and with both pumps operating and header valves open. Plot operating point on a clean copy of the pump curve 8-1/2" x 11" minimum.
- D. Verify calibration of temperature transmitters and thermometers.
- E. Record entering and leaving chilled water and tower water temperature and pressure for an outside air wet bulb less than 40°F (Note this test may have to be done during warranty period).

3.7 CONDENSER WATER PUMP OPERATIONAL TESTS:

- A. Coordinate with VFD installer during commissioning and start up of condenser water VFDs to verify calibration and operation of VFD.
- B. Read shut-off head, pump suction and discharge pressure and motor ampacity at each manually set VFD position from 30% to 100% in 10% increments. Use compound gage to verify differential pressure transducer. Use ultrasonic flowmeter to measure flow. Record data in the following format:

<u>% Speed</u>	<u>Shut off (psi)</u>	<u>Suction (psi)</u>	<u>Discharge (psi)</u>	<u>CPAS dp</u>	<u>Flow (gpm)</u>
30					
40					
50					
60					
70					
80					
90					
100					

3.8 COOLING TOWER DISTRIBUTION OPERATIONAL TEST:

- A. Read cooling tower distribution leader flow for the following pump conditions. Use ultrasonic flow meter to measure flow, use compound gage to measure header pressure.

<u>% Speed</u>	<u>Header (psi)</u>	<u>Flow (gpm)</u>
30		
40		
50		
60		
70		
80		
90		
100		

END OF SECTION

## SECTION 15995

### MECHANICALSYSTEMSCOMMISSIONING

#### PART 1 GENERAL

##### 1.1 DESCRIPTION:

- A. The purpose of this section is to specify Division 15 responsibilities in the commissioning process.
- b. Commissioning requires the participation of Division 15 to ensure that all systems are operating in a manner consistent with the Contract Documents. The general commissioning requirements and coordination are detailed in Division 17. Division 15 shall be familiar with all parts of Division 17 and the commissioning plan issued by the CA and shall execute all commissioning responsibilities assigned to them in the Contract Documents.

##### 1.2 RESPONSIBILITIES

- A. Mechanical, Controls and TAB Contractors. The commissioning responsibilities applicable to each of the mechanical, controls and TAB contractors of Division 15 are as follows (all references apply to commissioned equipment only):
  - 1. Construction and Acceptance Phases:
    - a. Include and itemize the cost of commissioning in the contract price.
    - b. In each purchase order or subcontract written, include requirements for submittal data, commissioning documentation, O&M data and training.
    - c. Attend a commissioning scoping meeting and other meetings necessary to facilitate the Cx process.
    - d. Contractors shall provide the CA with normal cut sheets and shop drawing submittals of commissioned equipment.
    - e. Provide additional requested documentation, prior to normal O&M manual submittals, to the CA for development of start-up and functional testing procedures.
      - 1) Typically this will include detailed manufacturer installation and start-up, operating, troubleshooting and maintenance procedures, full details of any owner-contracted tests, fan and pump curves, full factory testing reports, if any, and full warranty information, including all responsibilities of the Owner to keep the warranty in force clearly identified. In addition, the installation, start-up and checkout materials that are actually shipped inside the equipment and the actual field checkout sheet forms to be used by the factory or field technicians shall be submitted to the Commissioning Agent.
      - 2) The Commissioning Agent may request further documentation necessary for the commissioning process.
      - 3). This data request may be made prior to normal submittals.
  - f. Provide a copy of the O&M manuals and submittals of commissioned equipment, through normal channels, to the CA for review and approval.

- g. Contractors shall assist (along with the design engineers) in clarifying the operation and control of commissioned equipment in areas where the specifications, control drawings or equipment documentation is not sufficient for writing detailed testing procedures.
  - h. Provide limited assistance to the CA in preparing the specific functional performance test procedures as specified in Section 15997. Subs shall review test procedures to ensure feasibility, safety and equipment protection and provide necessary written alarm limits to be used during the tests.
  - i. Develop a full start-up and initial checkout plan using manufacturer's start-up procedures and the prefunctional checklists from the CA for all commissioned equipment. Submit to CA for review and approval prior to startup. Refer to Section 17100 for further details on start-up plan preparation.
  - j. During the startup and initial checkout process, execute the mechanical-related portions of the prefunctional checklists for all commissioned equipment.
  - k. Perform and clearly document all completed startup and system operational checkout procedures, providing a copy to the CA.
  - l. Address current A/E punch list items before functional testing. Chemical treatment, air and water hydrostatic testing and TAB shall be completed with discrepancies and problems remedied before functional testing of the respective air- or water-related systems.
  - m. Provide skilled technicians to execute starting of equipment and to execute the functional performance tests. Ensure that they are available and present during the agreed upon schedules and for sufficient duration to complete the necessary tests, adjustments and problem-solving.
  - n. Provide skilled technicians to perform functional performance testing under the direction of the CA for specified equipment in Section 15997 and 17100. Assist the CA in interpreting the monitoring data, as necessary.
  - o. Correct deficiencies (differences between specified and observed performance) as interpreted by the CA, CM and A/E and retest the equipment.
  - p. Prepare O&M manuals according to the Contract Documents, including clarifying and updating the original sequences of operation to as-built conditions.
  - q. During construction, maintain as-built red-line drawings for all drawings and final CAD as-builts for contractor-generated coordination drawings. Update after completion of commissioning (excluding deferred testing).
  - r. Provide training of the Owner's operating staff using expert qualified personnel, as specified.
  - s. Coordinate with equipment manufacturers to determine specific requirements to maintain the validity of the warranty.
2. WarrantyPeriod:
- a. Execute seasonal or deferred functional performance testing, witnessed by the CA, according to the specifications.

- b. Correct deficiencies and make necessary adjustments to O&M manuals and as-built drawings for applicable issues identified in any seasonal testing.
- B. Mechanical Contractor. The responsibilities of the mechanical contractor, during construction and acceptance phases in addition to those listed in (A) are:
  1. Provide startup for all HVAC, plumbing and utility plant equipment, except for the Plant Control and Automation System (CPAS), water chillers, and cooling towers.
  2. Assist and cooperate with the TAB contractor and CA by:
    - a. Putting all equipment and systems into operation and continuing the operation during each working day of TAB and commissioning, as required.
    - b. Including cost of sheaves and belts that may be required by TAB.
    - c. Providing test holes in ducts and plenums where directed by TAB to allow air measurements and air balancing. Providing an approved plug.
    - d. Providing temperature and pressure taps according to the Construction Documents for TAB and commissioning testing.
  3. Assist and cooperate with the chemical treatment vendor, water chiller provider and cooling tower component provider.
  4. Install a P/T plug at each water sensor which is an input point to the control system.
  5. List and clearly identify on the as-built drawings the locations of all air-flow stations.
  6. Prepare a preliminary schedule for Division 15 pipe and duct system testing, flushing and cleaning, equipment start-up and TAB start and completion for use by the CA. Update the schedule as appropriate.
  7. Notify the CM or CA depending on protocol, when pipe and duct system testing, flushing, cleaning, startup of each piece of equipment and TAB will occur. Be responsible to notify the CM or CA, ahead of time, when commissioning activities not yet performed or not yet scheduled will delay construction. Be proactive in seeing that commissioning processes are executed and that the CA has the scheduling information needed to efficiently execute the commissioning process.
- C. Controls Contractor (CPAS): The commissioning responsibilities of the Owner furnished Chiller Plant Automatic System Supplier, during construction and acceptance phases in addition to those listed in (A) are:
  1. Sequences of Operation Submittals. The Controls Contractor's submittals of control drawings shall include complete detailed sequences of operation for each piece of equipment, regardless of the completeness and clarity of the sequences in the specifications. They shall include:
    - a. An overview narrative of the system (1 or 2 paragraphs) generally describing its purpose, components and function.
    - b. All interactions and interlocks with other systems.
    - c. Detailed delineation of control between any packaged controls and the building automation system, listing what points the BAS monitors only and what BAS points are control points and are adjustable.
    - d. Written sequences of control for packaged controlled equipment. (Equipment manufacturers' stock sequences may be included, but will generally require additional narrative).

- e. Start-up sequences.
- f. Warm-up mode sequences.
- g. Normal operating mode sequences.
- h. Unoccupied mode sequences.
- i. Shutdown sequences.
- j. Capacity control sequences and equipment staging.
- k. Temperature and pressure control: setbacks, setups, resets, etc.
- l. Detailed sequences for all control strategies, e.g., economizer control, optimum start/stop, staging, optimization, demand limiting, etc.
- m. Effects of power or equipment failure with all standby component functions.
- n. Sequences for all alarms and emergency shut downs.
- o. Seasonal operational differences and recommendations.
- p. Initial and recommended values for all adjustable settings, setpoints and parameters that are typically set or adjusted by operating staff; and any other control settings or fixed values, delays, etc. that will be useful during testing and operating the equipment.
- q. Schedules, if known.
- r. To facilitate referencing in testing procedures, all sequences shall be written in small statements, each with a number for reference. For a given system, numbers will not repeat for different sequence sections, unless the sections are numbered.

2. Control Drawings Submittal:

- a. The control drawings shall have a key to all abbreviations.
- b. The control drawings shall contain graphic schematic depictions of the systems and each component.
- c. The schematics will include the system and component layout of any equipment that the control system monitors, enables or controls, even if the equipment is primarily controlled by packaged or integral controls.
- d. Provide a full points list with at least the following included for each point:
  - 1) Controlled system
  - 2) Point abbreviation
  - 3) Point description
  - 4) Display unit
  - 5) Control point or setpoint (Yes / No)
  - 6) Monitoring point (Yes / No)
  - 7) Intermediate point (Yes / No)
  - 8) Calculated point (Yes / No)

Key:

Point Description: DB temp, airflow, etc.

Control or Setpoint: Point that controls equipment and can have its setpoint changed (OSA, SAT, etc.)

Intermediate Point: Point whose value is used to make a calculation which then controls equipment (space temperatures that are averaged to a virtual point to control reset).

Monitoring Point: Point that does not control or contribute to the control of equipment, but is used for operation, maintenance, or performance verification.

Calculated Point: "Virtual" point generated from calculations of other point values.

The Controls Contractor shall keep the CA informed of all changes to this list during programming and setup.

3. An updated as-built version of the control drawings and sequences of operation shall be included in the final controls O&M manual submittal.
4. Assist and cooperate with the TAB contractor in the following manner:
  - a. Meet with the TAB contractor prior to beginning TAB and review the TAB plan to determine the capabilities of the control system toward completing TAB. TAB any needed unique instruments for setting unit controls and instruct TAB in their use (handheld control system interface).
  - b. For a given area, have all required prefunctional checklists, calibrations, startup and selected functional tests of the system completed and approved by the CA prior to TAB.
  - c. Provide a qualified technician to operate the controls to assist the TAB contractor in performing TAB, or provide sufficient training for TAB to operate the system without assistance.
5. Assist and cooperate with the CA in the following manner:
  - a. Using a skilled technician who is familiar with this building, execute the functional testing of the controls system as specified for the controls contractor in Section 15997 and 16997. Assist in the functional testing of all equipment specified in Section 15997 and 16997. Provide two-way radios during the testing.
  - b. Execute all control system trend logs specified in Section 15997 and 16997.
6. The controls contractor shall prepare a written plan indicating in a step-by-step manner, the procedures that will be followed to test, checkout and adjust the control system prior to functional performance testing, according to the process in Section 17100. At minimum, the plan shall include for each type of equipment controlled by the automatic controls:
  - a. System name.
  - b. List of devices.
  - c. Step-by-step procedures for testing each controller after installation, including:
    - 1) Process of verifying proper hardware and wiring installation.
    - 2) Process of downloading programs to local controllers and verifying that they are addressed correctly.
    - 3) Process of performing operational checks of each controlled component.
    - 4) Plan and process for calibrating valve and damper actuators and all sensors.

- 5) A description of the expected field adjustments for transmitters, controllers and control actuators should control responses fall outside of expected values.
  - d. A copy of the log and field checkout sheets that will document the process. This log must include a place for initial and final read values during calibration of each point and clearly indicate when a sensor or controller has "passed" and is operating within the contract parameters.
  - e. A description of the instrumentation required for testing.
  - f. Indicate what tests on what systems should be completed prior to TAB using the control system for TAB work. Coordinate with the CA and TAB contractor for this determination.
7. Provide a signed and dated certification to the CA and CM upon completion of the checkout of each controlled device, equipment and system prior to functional testing for each piece of equipment or system, that all system programming is complete as to all respects of the Contract Documents, except functional testing requirements.
  8. Beyond the control points necessary to execute all documented control sequences, provide monitoring, control and virtual points as specified in Section 15950.
  9. List and clearly identify on the as-built duct and piping drawings the locations of all static and differential pressure sensors (air, water and building pressure).
- D. TAB Contractor. The duties of the TAB contractor, in addition to those listed in (A) are:
1. Six weeks prior to starting TAB, submit to the CM the qualifications of the site technician for the project, including the name of the contractors and facility managers of recent projects the technician on which was lead. The Owner will approve the site technician's qualifications for this project.
  2. Submit the outline of the TAB plan and approach for each system and component to the CA, CM and the controls contractor six weeks prior to starting the TAB. This plan will be developed after the TAB has some familiarity with the control system.
  3. The submitted plan will include:
    - a. Certification that the TAB contractor has reviewed the construction documents and the systems with the design engineers and contractors to sufficiently understand the design intent for each system.
    - b. An explanation of the intended use of the building control system. The controls contractor will comment on feasibility of the plan.
    - c. All field checkout sheets and logs to be used that list each piece of equipment to be tested, adjusted and balanced with the data cells to be gathered for each.
    - d. Discussion of what notations and markings will be made on the duct and piping drawings during the process.
    - e. Final test report forms to be used.
    - f. Detailed step-by-step procedures for TAB work for each system and issue: terminal flow calibration (for each terminal type), diffuser proportioning, branch / submain proportioning, total flow calculations, rechecking, diversity issues, expected problems and solutions, etc. Criteria for using flow straighteners or relocating flow stations and sensors will be discussed.

- g. List of all air flow, water flow, sound level, system capacity and efficiency measurements to be performed and a description of specific test procedures, parameters, formulas to be used.
  - h. Details of how total flow will be determined (Air: sum of terminal flows or via hood readings of all terminals, supply (SA) and return air (RA) pitot traverse, SA or RA flow stations. Water: pump curves, circuit setter, flow station, ultrasonic, etc.).
  - i. The identification and types of measurement instruments to be used and their most recent calibration date.
  - j. Specific procedures that will ensure that both air and water side are operating at the lowest possible pressures and provide methods to verify this.
  - k. Confirmation that TAB understands the outside air ventilation criteria under all conditions.
  - l. Details of whether and how minimum outside air cfm will be verified and set, and for what level (total building, zone, etc.).
  - m. Proposed selection points for sound measurements and sound measurement methods.
  - n. Details of methods for making any specified coil or other system plant capacity measurements.
  - o. Details regarding specified deferred or seasonal TAB work.
  - p. Details of any specified false loading of systems to complete TAB work.
  - q. Details of all exhaust fan balancing and capacity verifications, including any required room pressure differentials.
  - r. Plan for hand-written field technician logs of discrepancies, deficient or uncompleted work by others, contract interpretation requests and lists of completed tests (scope and frequency).
  - s. Plan for formal progress reports (scope and frequency).
  - t. Plan for formal deficiency reports (scope, frequency and distribution).
4. A running log of events and issues shall be kept by the TAB field technicians. Submit hand-written reports of discrepancies, deficient or uncompleted work by others, contract interpretation requests and lists of completed tests to the CA and CM at least twice a week.
  5. Communicate in writing to the controls contractor all setpoint and parameter changes made or problems and discrepancies identified during TAB which affect the control system setup and operation.
  6. Provide a draft TAB report within two weeks of completion. A copy will be provided to the CA. The report will contain a full explanation of the methodology, assumptions and the results in a clear format with designations of all uncommon abbreviations and column headings. The report should follow the latest and most rigorous reporting recommendations by AABC, NEBB or ASHRAE Standard 111.



7. Provide the CA with any requested data, gathered, but not shown on the draft reports.
8. Provide a final TAB report for the CA with details, as in the draft.
9. Conduct functional performance tests and checks on the original TAB as specified for TAB in Section 15997.

## PART 2 PRODUCTS

### 2.1 TESTEQUIPMENT:

- A. Division 15 shall provide all test equipment necessary to fulfill the testing requirements of this Division.

## PART 3 EXECUTION

### 3.1 SUBMITTALS:

- A. Division 15 shall provide submittal documentation relative to commissioning as required in this Section Part 1.

### 3.2 STARTUP:

- A. The mechanical and controls contractors shall follow the start-up and initial checkout procedures listed in the Responsibilities list in this section and in 17100. Division 15 has start-up responsibility and is required to complete systems and sub-systems so they are fully functional, meeting the design objectives of the Contract Documents. The commissioning procedures and functional testing do not relieve or lessen this responsibility or shift that responsibility partially to the commissioning agent or Owner.
- B. Functional testing is intended to begin upon completion of a system. Functional testing may proceed prior to the completion of systems or sub-systems at the discretion of the CA and CM. Beginning system testing before full completion, does not relieve the Contractor from fully completing the system, including all prefunctional checklists as soon as possible.

### 3.3 TAB:

- A. Refer to the TAB responsibilities in Part 1.2 above.

### 3.4 FUNCTIONALPERFORMANCETESTS:

- A. Refer to Section 15997 for specific details on the required functional performance tests.

### 3.5 OPERATION AND MAINTENANCE (O&M) MANUALS:

- A. The following O&M manual requirements do not replace O&M manual documentation requirements elsewhere in these specifications.
- B. Division 15 shall compile and prepare documentation for all equipment and systems covered in Division 15 and deliver this documentation to the GC for inclusion in the O&M manuals, according to this section and Section 01730, prior to the training of owner personnel.
- C. The CA shall receive a copy of the O&M manuals for review.
- D. Special Control System O&M Manual Requirements. In addition to documentation that may be specified elsewhere, the controls contractor shall compile and organize at minimum the following data on the control system in labeled 3-ring binders with indexed tabs.

1. Three copies of the controls training manuals in a separate manual from the O&M manuals.
  2. Operation and Maintenance Manuals containing:
    - a. Specific instructions on how to perform and apply all functions, features, modes, etc. mentioned in the controls training sections of this specification and other features of this system. These instructions shall be step-by-step. Indexes and clear tables of contents shall be included. The detailed technical manual for programming and customizing control loops and algorithms shall be included.
    - b. Full as-built set of control drawings (refer to Submittal section above for details).
    - c. Full as-built sequence of operations for each piece of equipment.
    - d. Full points list.
    - e. Full print out of all schedules and set points after testing and acceptance of the system.
    - f. Full as-built print out of software program.
    - g. Electronic copy on disk of the entire program for this facility.
    - h. Marking of all system sensors on the as-built floor plan and mechanical drawings with their control system designations.
    - i. Maintenance instructions, including sensor calibration requirements and methods by sensor type, etc.
    - j. Control equipment component submittals, parts lists, etc.
    - k. Warranty requirements.
    - l. Copies of all checkout tests and calibrations performed by the Contractor (not commissioning tests).
  3. The manual shall be organized and subdivided with permanently labeled tabs for each of the following data in the given order:
    - a. Sequences of operation
    - b. Control drawings
    - c. Points lists
    - d. Controller / module data
    - e. Thermostats and timers
    - f. Sensors and DP switches
    - g. Valves and valve actuators
    - h. Dampers and damper actuators
    - i. Program setups (software program printouts)
  4. Field checkout sheets and trend logs should be provided to the CA for inclusion in the Commissioning Record Book.
- E. Special TAB Documentation Requirements. The TAB will compile and submit the following with other documentation that may be specified elsewhere in the *Specifications*.
1. Final report containing an explanation of the methodology, assumptions, test conditions and the results in a clear format with designations of all uncommon abbreviations and column headings.
  2. The TAB shall mark on the drawings where all traverse and other critical measurements were taken and cross reference the location in the TAB report.

- F. Review and Approvals\_ Review of the commissioning related sections of the O&M manuals shall be made by the A/E and by the CA.

3.6 TRAINING OF OWNER PERSONNEL:

- A. The GC shall be responsible for training coordination and scheduling and ultimately to ensure that training is completed.
- B. The CA shall be responsible for overseeing and approving the content and adequacy of the training of Owner personnel for commissioned equipment.
- C. Mechanical Contractor\_ The mechanical contractor shall have the following training responsibilities:
  - 1. Provide designated Owner personnel with comprehensive orientation and training in the understanding of the systems and the operation and maintenance of each piece of equipment including, but not limited to, pumps, chillers, heat rejection equipment, air conditioning units, air handling units, fans, terminal units, controls and water treatment systems, etc.
  - 2. Training shall normally start with classroom sessions followed by hands-on training on each piece of equipment, which shall illustrate the various modes of operation, including startup, shutdown, fire/smoke alarm, power failure, etc.
  - 3. During any demonstration, should the system fail to perform in accordance with the requirements of the O&M manual or sequence of operations, the system will be repaired or adjusted as necessary and the demonstration repeated.
  - 4. The appropriate trade or manufacturer's representative shall provide the instructions on each major piece of equipment. This person may be the start-up technician for the piece of equipment, the installing contractor or manufacturer's representative. Practical plant operating expertise as well as in-depth knowledge of all modes of operation of the specific piece of equipment are required. More than one party may be required to execute the training.
  - 5. The controls contractor shall attend sessions other than the controls training, as requested, to discuss the interaction of the controls system as it relates to the equipment being discussed.
  - 6. The training sessions shall follow the outline in the Table of Contents of the operation and maintenance manual and illustrate whenever possible the use of the O&M manuals for reference.
  - 7. Training shall include:
    - a. Use of the printed installation, operation and maintenance instruction material included in the O&M manuals.
    - b. A review of the written O&M instructions emphasizing safe and proper operating requirements, preventative maintenance, special tools needed and spare parts inventory suggestions. The training shall include start-up, operation in all modes possible, shut-down, seasonal changeover and any emergency procedures.
    - c. Discussion of relevant health and safety issues and concerns.
    - d. Discussion of warranties and guarantees.

- e. Common troubleshooting problems and solutions.
  - f. Explanatory information included in the O&M manuals and the location of all plans and manuals in the facility.
  - g. Discussion of any peculiarities of equipment installation or operation.
  - h. The format and training agenda in *The HVAC Commissioning Process, ASHRAE Guideline 1-1989R*, 1996 will be used unless otherwise approved.
  - i. Classroom sessions shall include the use of overhead projections, slides, video/audio-taped material as might be appropriate.
8. Hands-on training shall include start-up, operation in all modes possible, including manual, shut-down and any emergency procedures and preventative maintenance for all pieces of equipment.
  9. The mechanical contractor shall fully explain and demonstrate the operation, function and overrides of any local packaged controls, not *controlled* by the central control system.
  10. Training shall occur after functional testing is complete, unless approved otherwise by the Project Manager.
  11. Duration of Training. The mechanical contractor shall provide training on each piece of equipment according to the following schedule, or as indicated in the individual technical specifications.

<u>Hours</u>	<u>System</u>
8	Chillers and System
8	Cooling Towers
4	Side Stream Filtration
8	Piping Systems
1	Chemical Treatment
8	Air Compressors and dryers
4	Air Handler Units
16	Variable Speed Drives
4	Heat Exchangers
1	Air Terminal Units
4	Air Handler Units
1	Specialty Exhaust Fans

- D. Owner Furnished Controls Contractor. The controls contractor shall have the following training responsibilities:
1. Provide the CA with a training plan four weeks before the planned training according to the outline described in Section 17100, Part 3.9.
  2. The controls contractor shall provide designated Owner personnel training on the control system in this facility. The intent is to clearly and completely instruct the Owner on all the capabilities of the control system.
  3. Training manuals. The standard operating manual for the system and any special training manuals will be provided for each trainee, with three extra copies left for the O&M manuals. In addition, copies of the system technical manual will be demonstrated during training and three copies submitted with the O&M manuals. Manuals shall

include detailed description of the subject matter for each session. The manuals will cover all control sequences and have a definitions section that fully describes all relevant words used in the manuals *and* in all software displays. Manuals will be approved by the CA. Copies of audiovisuals shall be delivered to the Owner.

4. The trainings will be tailored to the needs and skill-level of the trainees.
5. The trainers will be knowledgeable on the system and its use in buildings. For the on-site sessions, the most qualified trainer(s) will be used. The Owner shall approve the instructor prior to scheduling the training.
6. During any demonstration, should the system fail to perform in accordance with the requirements of the O&M manual or sequence of operations, the system will be repaired or adjusted as necessary and the demonstration repeated.
7. The controls contractor shall attend sessions other than the controls training, as requested, to discuss the interaction of the controls system as it relates to the equipment being discussed.
8. There shall be three training sessions:
  - a. Training I. Control System. The first training shall consist of 16 hours of actual training. This training may be held on-site or in the supplier's facility. If held off-site, the training may occur prior to final completion of the system installation. Upon completion, each student, using appropriate documentation, should be able to perform elementary operations and describe general hardware architecture and functionality of the system.
  - b. Training II. Building Systems. The second session shall be held on-site for a period of 24 hours of actual hands-on training after the completion of system commissioning. The session shall include instruction on:
    - 1) Specific hardware configuration of installed systems in this building and specific instruction for operating the installed system, including plant, HVAC systems, lighting controls and any interface with security and communications systems.
    - 2) Security levels, alarms, system start-up, shut-down, power outage and restart routines, changing setpoints and alarms and other typical changed parameters, overrides, freeze protection, manual operation of equipment, optional control strategies that can be considered, energy savings strategies and set points that if changed will adversely affect energy consumption, energy accounting, procedures for obtaining vendor assistance, etc.
    - 3) All trending and monitoring features (values, change of state, totalization, etc.), including setting up, executing, downloading, viewing both tabular and graphically and printing trends. Trainees will actually set-up trends in the presence of the trainer.
    - 4) Every screen shall be completely discussed, allowing time for questions.
    - 5) Use of keypad or plug-in laptop computer at the zone level.
    - 6) Use of remote access to the system via phone lines or networks.
    - 7) Setting up and changing an air terminal unit controller.

- 8) Graphics generation
  - 9) Point database entry and modifications
  - 10) Understanding DDC field panel operating programming (when applicable)
  - c. Training III. The third training will be conducted on-site six months after occupancy and consist of 16 hours of training. The session will be structured to address specific topics that trainees need to discuss and to answer questions concerning operation of the system.
- E. TAB: The TAB contractor shall have the following training responsibilities:
- 1. TAB shall meet for 4 hours with facility staff after completion of TAB and instruct them on the following:
    - a) Go over the final TAB report, explaining the layout and meanings of each data type.
    - b) Discuss any outstanding deficient items in control, ducting or design that may affect the proper delivery of air or water.
    - c) Identify and discuss any terminal units, duct runs, diffusers, coils, fans and pumps that are close to or are not meeting their design capacity.
    - d) Discuss any temporary settings and steps to finalize them for any areas that are not finished.
    - e) Other salient information that may be useful for facility operations, relative to TAB.

3.7 DEFERRED TESTING:

- A. Refer to Section 17100, Part 3.10 for requirements of deferred testing.

3.8 WRITTEN WORK PRODUCTS:

- A. Written work products of Contractors will consist of the start-up and initial checkout plan described in Section 17100 and the filled out start-up, initial checkout and prefunctional checklists.

END OF SECTION

SECTION 15997

MECHANICAL TESTING REQUIREMENTS

PART 1 GENERAL

1.1 INCLUDED SYSTEMS AND EQUIPMENT

- A. The following is a list of the mechanical equipment and systems to be commissioned under this section:
1. Air Compressor System
  2. Air Handler System
  3. Central Plant Automation System
  4. Chemical Treatment System
  5. Cooling Tower Systems
  6. Exhaust Fan System
  7. Glycol Heating System
  8. Hot Water System
  9. Refrigerant Alarm System
  10. Side Stream Filtration Systems
  11. Terminal Unit (fan coil)
  12. Water Chiller Systems

1.2 DESCRIPTION

- A. This section specifies the general functional testing requirements for Division 15 systems and equipment. From these requirements, the Commissioning Authority (CA) shall develop step-by-step procedures to be executed by the Contractor or the Commissioning Authority. The general functional testing process, requirements and test method definitions are described in Section 17100. The test requirements for each piece of equipment or system contain the following:
1. The contractors responsible to execute the tests, under the direction of the CA.
  2. A list of the integral components being tested.
  3. Prefunctional checklists associated with the components.
  4. Functions and modes to be tested.
  5. Required conditions of the test for each mode.
  6. Special procedures.
  7. Required methods of testing.
  8. Required monitoring.
  9. Acceptance criteria.
  10. Sampling strategies allowed.

1.3 PREREQUISITES:

The following applicable generic prerequisite checklist items are required to be listed on each written functional test form and be completed and checked off by CA prior to functional testing.

\_\_\_ All related equipment has been started up and start-up reports and prefunctional checklists submitted and approved ready for functional testing:

\_\_\_ All control system functions for this and all interlocking systems are programmed and operable per contract documents, including final setpoints and schedules with debugging, loop tuning and sensor calibrations completed.

\_\_\_\_\_  
Controls Contractor Signature or Verbal

\_\_\_\_\_  
Date

- \_\_\_ Piping system flushing complete and required report approved.
- \_\_\_ Water treatment system complete and operational.
- \_\_\_ Test and balance (TAB) complete and approved for the hydronic system.
- \_\_\_ All A/E punchlist items for this equipment corrected.
- \_\_\_ These functional test procedures reviewed and approved by installing contractor.
- \_\_\_ Safeties and operating ranges reviewed by the CA.
- \_\_\_ Test requirements and sequences of operation attached.
- \_\_\_ Schedules and setpoints attached.
- \_\_\_ False loading equipment, system and procedures ready.
- \_\_\_ Crankcase heaters have been on long enough for immediate startup.
- \_\_\_ Sufficient clearance around equipment for servicing.
- \_\_\_ Record of all values for pre-test setpoints changed to accommodate testing has been made and a check box provided to verify return to original values (control parameters, limits, delays, lockouts, schedules, etc.).
- \_\_\_ Other miscellaneous checks of the prefunctional checklist and start-up reports completed successfully.

1.4 MONITORING:

- A. Monitoring is a method of testing as a stand-alone method or to augment manual testing.
- B. All points listed in the required monitoring section of the test requirements which are control system monitored points shall be trended by the controls contractor. Other points shall be monitored by the CA using dataloggers. At the option of the CA, some control system monitoring may be replaced with datalogger monitoring. At the CA's request, the controls contractor shall trend up to 20% more points than listed herein at no extra charge.
- C. Hard copies of monitored data must be in columnar format with time down the left column and at least 5 columns of point values on the same page.
- D. Graphical output is desirable, and will be required for all output, if the system can produce it.

PART 2 PRODUCTS

NOT APPLICABLE

PART 3 - EXECUTION

3.1 FUNCTIONAL TEST EXAMPLES:

- A. The following are representative samples and examples of the type and level of detail of the Functional Performance testing to be done on each system identified in 1.01A. Final Functional tests will be developed during the commissioning process.
- B. Detailed functional performance tests will be developed by the CA following submittal approval.

3.2 EXAMPLE #1: AIR HANDLER UNITS (AHU):

- A. Parties Responsible to Execute Functional Test
  - 1. Controls contractor: operate the controls to activate the equipment as needed.
  - 2. CA: to witness, direct and document testing.
- B. Integral Components or Related Equipment Being Tested Prefunctional Checklist ID
  - 1. AHU and components (fans, coils, valves, ducts, VFD) PC-\_\_\_\_\_



2. Evaporative cooling sections

PC-\_\_\_\_\_

C. Prerequisites: The applicable prerequisite checklist items listed in the beginning of Section 15997 shall be listed on each functional test form and checked off prior to functional testing. The commissioning agent will also spot-check misc. items and calibrations on the prefunctional checklists previously completed by the installer, before the beginning of functional testing.

D. Functions / Modes Required To Be Tested, Test Methods and Seasonal Test Requirements:

The following testing requirements are an addition to and do not replace any testing requirements elsewhere in this Division.

<u>Function / Mode</u>	<u>Test Method</u> Manual, Monitoring, Either or Both <sup>3</sup>	<u>Required</u> <u>Seasonal</u> <u>Test</u> <sup>1</sup>
General 1. Test each sequence in the sequence of operations, and other significant modes and sequences not mentioned; including startup, shutdown, unoccupied & manual modes and power failure. Test functionality of this piece of equipment or system in all control strategies or interlocks with which it is associated.	Manual	
In addition to, or as part of (1) above, the following modes or tests are required:		
2. Reset temperature control functions.	Both	
3. SF and exhaust fan interlocks.	Either	
4. HCV modulation & positive shutoff (no leak-thru). 5. VFD operation on SF: modulation to minimum, control system PID, proportional band of speed vs. controlling parameter, constancy of static pressure, verification of program settings, alarms, etc.	Manual Both	<sup>2</sup>
6. Damper interlocks and correct modulation in all modes.	Manual	
7. Temperature difference across HC per specifications.	Manual	<sup>2</sup>
8. Coils freeze protection.	Manual	<sup>2</sup>
9. Verify TAB reported SF cfm with control system reading.	Manual	<sup>2</sup>
10. All alarms (low limits, high static, etc.).	Manual	
11. Heating and cooling coil capacity test.	Manual	Design
12. Sensor and actuator calibration checks	Manual	
13. Verify schedules and setpoints to be reasonable and appropriate		

<sup>1</sup>Cooling season, Heating season or Both. "Design" means within 5° of season design (ASHRAE 2 1/2%), or 95% of loading design. A blank cell denotes no special seasonal test is required and that test can be executed during any season, if condition simulation is appropriate.

<sup>2</sup>Seasonal test not required if seasonal conditions can be adequately simulated.

<sup>3</sup>Refer to Special Procedures

E. Required Monitoring

1. All points listed below which are control system monitored points shall be trended by the controls contractor. Other points shall be monitored by the CA using dataloggers. Refer to the Monitoring section at the beginning of Section 15997 for additional monitoring details.

Point	Time Step (min.)	Minimum Time Period of Trend	Hard Copy? (Y/N)	ASCII File? (Y/N)	Function Being Tested
For each AHU being tested:					
SAT	5	5 days incl. weekend	Y	Y	1-3, 5
HC LAT	5	5 days incl. weekend	Y	Y	1-3, 5
SF speed, if variable, else status	5	5 days incl. weekend	Y	Y	1, 5-9
OSAT	5	5 days incl. weekend	Y	Y	All
OSA-WB	5	5 days incl. weekend	Y	Y	1, 3
Indoor dry-bulb 2 zones (expected to be most problematic)	5	5 days incl. weekend	Y	Y	All

Remarks:

HCV position (optional)  
 SF cfm not required if not monitored  
 RF cfm not required if not monitored

F. Acceptance Criteria (referenced by function or mode ID)

- 1-21. For the conditions, sequences and modes tested, the AHU, integral components and related equipment respond to varying loads and changing conditions and parameters appropriately as expected, as specified and according to acceptable operating practice.
2. AHU with supporting systems shall be able to maintain the SA temperature within 1.0F either side of the deadband of the current setpoint without excessive hunting.
7. AHU and controls shall control the duct static pressure so that it does not drift more than an amount equal to 10% of the setpoint value either side of the deadband without excessive hunting.

3.3. EXAMPLE #2: HEATING WATER SYSTEM:

A. Parties Responsible to Execute Functional Test

1. Controls contractor: operate the controls, as needed.
2. HVAC mechanical contractor or vendor: assist in testing sequences.
3. CA: to witness, direct and document testing.

B. Integral Components or Related Equipment Being Tested

Prefunctional Checklist ID

- |                                |       |
|--------------------------------|-------|
| 1. Steam – Glycol water heater | PC-__ |
| 2. Primary HW supply pumps     | PC-__ |
| 3. Heating water piping system | PC-__ |
| 4. Secondary HW supply pumps   | PC-__ |

C. Prerequisites: The applicable prerequisite checklist items listed in the beginning of Section 15997 shall be listed on each functional test form and checked off prior to functional testing. The commissioning agent will also spot-check misc. items and calibrations on the

prefunctional checklists previously completed by the installer, before the beginning of functional testing.

D. Functions / Modes Required To Be Tested, Test Methods and Seasonal Test Requirements:

The following testing requirements are in addition to and do not replace any testing requirements elsewhere in this Division.

<u>Function / Mode</u>	<u>Test Method</u> Manual, Monitoring, Either or Both	<u>Required</u> <u>Seasonal</u> <u>Test</u> <sup>1</sup>
General 1. Test each sequence in the sequence of operations, and other significant modes and sequences not mentioned; including startup, shutdown, unoccupied & manual modes and power failure. Test functionality of this piece of equipment or system in all control strategies or interlocks that it is associated with.	Manual	
In addition to, or as part of (1) above, the following modes or tests are required:		
2. <u>Primary Side.</u> Lead/lag staging of heat exchangers, optimization, capacity modulation, and primary HW supply pumps.	Both	Heating
3. <u>Secondary Side.</u> Secondary WH supply pump staging, bypass valve operation and HWT reset. Control system PID, proportional band of speed vs. controlling parameter, verification of program settings,, alarms, etc.	Both	Heating
4. Check all alarms and safeties (high and low pressure and temperature, etc.), PRV and flow switch functions	Manual	
5. Test each possible lead heat exchangers as lead heat exchangers, and each pump as lead pump. Test pump lockouts.	Manual	
6. Efficiency and capacity tests	Manual	Heating
7. Verify heat exchangers inlet/outlet pressures with startup report and manufacturer's recommendations	Manual	
8. Sensor and actuator calibration checks on: HWST, HWRT, pressure sensor controlling pump speed, mixing valve and other random checks (EMS readout against hand-held calibrated instrument must be within 0.5°F for temps. or within a tolerance equal to 10% of the pressure setpoint, with a test gage)	Manual	
9. Verify schedules and setpoints to be reasonable and appropriate		

<sup>1</sup>Cooling season, Heating season or Both. "Design" means within 5° of season design (ASHRAE 2 1/2%), or 95% of loading design. A blank cell denotes no special seasonal test is required and that test can be executed during any season, if condition simulation is appropriate.

E. Special Procedures (other equipment to test with, etc.; reference to function ID)

1. False load heat exchangers, if necessary.

F. Required Monitoring

1. All points listed below which are control system monitored points shall be trended by the controls contractor. Other points shall be monitored by the CA using dataloggers. Refer to the Monitoring section at the beginning of Section 15997 for additional monitoring details.

Point	Time Step (min.)	Minimum Time Period of Trend	Hard Copy? (Y/N)	ASCII File? (Y/N)	Function Being Tested
For each boiler and pump:					
Heat exchanger current or status	5	5 days incl. weekend	Y	Y	1-3
HWST	5	5 days incl. weekend	Y	Y	1, 3
HWRT	5	5 days incl. weekend	Y	Y	1, 3
OSAT-DB	5	5 days incl. weekend	Y	Y	1-3
HWS primary pump current or status	5	5 days incl. weekend	Y	Y	1, 2

Remarks:

G. Acceptance Criteria (referenced by function or mode ID)

1-11. For the conditions, sequences and modes tested, the heat exchangers, integral components and related equipment respond to varying loads and changing conditions and parameters appropriately as expected, as specified and according to acceptable operating practice.

2. Boiler shall maintain the supply water setpoint to within +/- 1.0F of setpoint deadband without excessive hunting.

H. Sampling Strategy for Identical Units

1. No sampling, test all.

3.4 EXAMPLE #3: CHILLER PLANT AUTOMATION SYSTEM (CPAS):

A. Parties Responsible to Execute Functional Test

1. Controls contractor: operate the controls to activate the equipment.
2. CA: to witness, direct and document testing.

B. Integral Components or Related Equipment Being Tested Prefunctional Checklist ID

1. Chiller Plant Automation System PC-\_\_\_\_\_
2. All prefunctional checklists of controlled equipment ---

C. Prerequisites The applicable prerequisite checklist items listed in the beginning of Section 15997 shall be listed on each functional test form and checked off prior to functional testing. The commissioning agent will also spot-check misc. items and calibrations on the prefunctional checklists previously completed by the installer, before the beginning of functional testing.

D. A significant part of the CPAS functional testing requirements is the successful completion of the functional tests of equipment the CPAS controls or interlocks with. Uncompleted equipment functional tests or outstanding deficiencies in those tests lend the required CPAS functional testing incomplete.

E. Integral or stand-alone controls are functionally tested with the equipment they are attached to, including any interlocks with other equipment or systems and thus are not covered under the CPAS testing requirements, except for any integrated functions or interlocks listed below.

- F. In addition to the controlled equipment testing, the following tests are required for the CPAS, where features have been specified. The following testing requirements are in addition to and do not replace any testing requirements elsewhere in the specifications.

<u>Function / Mode</u>	<u>Test Method Manual (demonstration), Monitoring, Either or Both</u>
<b>MISC. FUNCTIONS</b>	
1. All specified functions and features are set up, debugged and fully operable	Verbal discussion of features
2. Power failure and battery backup and power-up restart functions	Demonstration
3. Specified trending and graphing features demonstration	See equipment trends
4. Global commands features	Demonstration
5. Security and access codes	Demonstration
6. Occupant over-rides (manual, telephone, key, keypad, etc.)	Demonstration
7. O&M schedules and alarms	Demonstration
8. Scheduling features fully functional and setup, including holidays	Observation in terminal screens or printouts
9. Date and time setting in central computer and verify field panels read the same time	Demonstration
10. Included features not specified to be setup are installed (list)	Demonstration
11. Occupancy sensors and controls	Demonstration
12. Demonstrate functionality of field panels using local operator keypads and local ports (plug-ins) using portable computer/keypad	Demonstration of 100% of panels and 10% of ports
13. All graphic screens and value readouts completed	Demonstration
14. Setpoint changing features and functions	Done during equipment testing
15. Communications to remote sites	Demonstration
16. Sensor calibrations	Sampled during equipment tests
17. "After hours" use tracking and billing	
18. Final as-builts or redlines (per spec) control drawings, final points list, program code, setpoints, schedules, warranties, etc. per specs, submitted for O&Ms.	Observation
19. Verify that points that are monitored only, having no control function, are checked for proper reporting to BAS.	Observation
<b>INTEGRATED TESTS</b>	
20. Fire alarm interlocks and response	Demonstration
21. Duty cycling	Monitoring
22. Demand limiting (including over-ride of limiting)	Monitoring
23. Sequential staging ON of equipment	Either
24. Optimum start-stop functions	Monitoring
25. All control strategies and sequences not tested during controlled equipment testing	Either
26. Other integrated tests specified in the contract documents	

- G. Special Procedures (other equipment to test with, etc.; reference to function ID)

None

- H. Additional Required Monitoring

1. Besides the trending and monitoring required with the functional testing of equipment, all points listed below which are control system monitored points shall be trended by the controls contractor. Other points shall be monitored by the CA using dataloggers. Refer to the Monitoring section at the beginning of Section 15997 for additional monitoring details.

Point	Time Step (min.)	Minimum Time Period of Trend	Hard Copy? (Y/N)	ASCII File? (Y/N)	Function Being Tested
Misc. equipment current or status for duty cycling and demand limiting	5	5 days incl. weekend	Y	Y	21-22
Equipment or building kW or current for demand limiting	5	5 days incl. weekend	Y	Y	21-22
Optimum start/stop equip.	5	5 days incl. weekend	Y	Y	24

Remarks:

I. Acceptance Criteria (referenced by function or mode ID)

All for the conditions, sequences and modes tested, the BAS, integral components and related equipment respond to changing conditions and parameters appropriately as expected, as specified and according to acceptable operating practice.

3.5. EXAMPLE #4: CHILLER:

The cooling tower can be tested integrally with the chiller testing. The cooling tower test requirements are listed elsewhere.

A. Parties Responsible to Execute Functional Test

1. Controls contractor: operate the controls as needed.
2. Mechanical contractor or vendor: assist in testing sequences as needed.
3. CA: to witness, direct and document testing.

B. Prerequisites: The applicable prerequisite checklist items listed in the beginning of Section 15997 shall be listed on each functional test form and checked off prior to functional testing. The commissioning agent will also spot-check misc. items and calibrations on the prefunctional checklists previously completed by the installer, before the beginning of functional testing.

C. Integral Components or Related Equipment Being Tested	Prefunctional Checklist ID
--	----------------------------

- |                                |       |
|--------------------------------|-------|
| 1. Chiller                     | PC-__ |
| 2. Primary CHW supply pumps    | PC-__ |
| 3. Chilled water piping system | PC-__ |
| 4. VFD on primary pumps        | PC-__ |
| 5. Cooling tower               | PC-__ |

D. Functions / Modes Required To Be Tested, Test Methods and Seasonal Test Requirements

The following testing requirements are an addition to and do not replace any testing requirements elsewhere in this Division.

<u>Function / Mode</u>	<u>Test Method</u> Manual, Monitoring, Either or Both	<u>Required</u> <u>Seasonal</u> <u>Test</u> <sup>1</sup>
General 1. Test each sequence in the sequence of operations, and other significant modes and sequences not mentioned; including startup, shutdown, unoccupied & manual modes and power failure. Test functionality of this piece of equipment or system in all control strategies or interlocks with which it is associated. A full cycle from no load to full load and then to no load and compressors off shall be demonstrated.	Manual	
In addition to, or as part of (1) above, the following modes or tests are required:		
2. <u>Primary Side.</u> Lead/lag staging of chillers, optimization, capacity modulation (loading and unloading), heat, and primary CHW supply pumps, VFD operation: modulation to minimum, control system PID, proportional band of speed vs. controlling parameter, alarms, verification of program settings, etc. all relating to maintaining CDW and CHW temperatures.	Both	Cooling
3. All alarms: high and low pressure, low oil, etc.	Manual	
4. Test each possible lead chiller as lead chiller, and each pump as lead pump, including standby pumps.	Manual	
5. KW/ton and APLV efficiency test	Manual	Cooling
6. Capacity test, optional	Manual	Cooling Design
7. Vibration test	Manual	Cooling Design
8. Sound test	Manual	Cooling Design
9. Thermographic test, optional	Manual	Cooling Design
10. Sensor and actuator calibration checks on: ECDWT, CHWST, pressure sensor controlling pump speed, and other random checks (EMS readout against handheld calibrated instrument must be within 0.5°F for temps. Or within a tolerance equal to 10% of the pressure setpoint, with a test gage)	Manual	
11. Verify schedules and setpoints to be reasonable and appropriate		

<sup>1</sup>Cooling season, Heating season or Both. "Design" means within 5°F of season design (ASHRAE 2 1/2%), or 95% of loading design. A blank cell denotes no special seasonal test is required and that test can be executed during any season, if condition simulation is appropriate.

E. Special Procedures (other equipment with which to test, etc.; reference to function ID):

1. Test with cooling tower in automatic mode.
2. False load chiller, if necessary.

F. Required Monitoring

1. All points listed below which are control system monitored points shall be trended by the controls contractor. Other points shall be monitored by the CA using dataloggers.



Refer to the Monitoring section at the beginning of Section 15997 for additional monitoring details.

Point	Time Step (min.)	Minimum Time Period of Trend	Hard Copy? (Y/N)	ASCII File? (Y/N)	Function Being Tested
For each chiller and pump:					
Chiller current and flow	5	45 days incl. weekend	Y	Y	1-3
ECDWT	5	45 days incl. weekend	Y	Y	1-3
LCDWT	5	45 days incl. weekend	Y	Y	1-3
CDW pump current or status	5	45 days incl. weekend	Y	Y	1-3
CHWST	5	45 days incl. weekend	Y	Y	1, 3
CHWRT	5	45 days incl. weekend	Y	Y	1, 3
OSAT-DB	5	45 days incl. weekend	Y	Y	1-3
CHWS primary pump current and speed	5	45 days incl. weekend	Y	Y	1, 2
Point	Time Step (min.)	Minimum Time Period of Trend	Hard Copy? (Y/N)	ASCII File? (Y/N)	Function Being Tested
CHWS primary pump speed controlling parameter value	5	45 days incl. weekend	Y	Y	1, 3

Remarks:

G. Acceptance Criteria (referenced by function or mode ID)

- 1-9. For the conditions, sequences and modes tested, the chillers, integral components and related equipment respond to varying loads and changing conditions and parameters appropriately as expected, as specified and according to acceptable operating practice.
2. Chiller shall maintain the chilled water supply setpoint to within +/- 1.0F of setpoint deadband without excessive hunting.
9. Pumping system and controls shall maintain the current desired pressure setpoint to within an amount equal to 10% of the setpoint value either side of the deadband without excessive hunting.

H. Sampling Strategy for Identical Units

1. No sampling, test all.

3.6 EXAMPLE #5: COOLING TOWER:

The cooling tower can be tested integrally with the chiller testing.

A. Parties Responsible to Execute Functional Test

1. Controls contractor: operate the controls, as needed.
2. HVAC mechanical contractor or vendor: assist in testing sequences, as needed.
3. CA: to witness, direct and document testing.

B. Integral Components or Related Equipment Being Tested

Prefunctional Checklist ID

1. Condenser water pump and VFD PC-\_\_
2. Cooling tower and components PC-\_\_
3. Condenser water piping system PC-\_\_
4. Fan VFD PC-\_\_

C. Prerequisites: The applicable prerequisite checklist items listed in the beginning of Section 15997 shall be listed on each functional test form and checked off prior to functional testing. The commissioning agent will also spot-check misc. items and calibrations on the prefunctional checklists previously completed by the installer, before the beginning of functional testing.

D. Functions / Modes Required To Be Tested, Test Methods and Seasonal Test Requirements

The following testing requirements are an addition to and do not replace any testing requirements elsewhere in this Division.

<u>Function / Mode</u>	<u>Test Method</u> Manual, Monitoring, Either or Both	<u>Required</u> <u>Seasonal</u> <u>Test</u> <sup>1</sup>
General 1. Test each sequence in the sequence of operations, and other significant modes and sequences not mentioned; including startup, shutdown, unoccupied & manual modes and power failure. Test functionality of this piece of equipment or system in all control strategies or interlocks with which it is associated.	Manual	
In addition to, or as part of (1) above, the following modes or tests are required:		
2. Cooling season modes of operation.	Both	Cooling
3. Heating season modes of operation.	Both	Heating
4. Lead/lag staging of towers, including testing each tower as lead tower. Staging of fans, condenser pumps, CDWT reset, time delays.	Both, except <sup>2</sup>	
5. Bypass valve operation and ability of CT to maintain entering CDW temperature.	Either	
6. Sump heater and freeze protection operation.	Either	Heating
7. All alarms: vibration, fan failure, high water, low water.	Manual	
8. Verify approach temperature with manuf. specs, optional.	Either	
9. VFD operation: modulation to low limit, controlling PID, proportional band of speed vs. control parameter, verification of program settings, alarms pumps and fans.	Both	
10. Capacity test.	Manual	Clg. Des.
11. Sensor and actuator calibration checks: See Chiller requirements.	Manual	
12. Verify schedules and setpoints to be reasonable and appropriate.		

<sup>1</sup>Cooling season, Heating season or Both. "Design" means within 5°F of season design (ASHRAE 2 1/2%), or 95% of loading design. A blank cell denotes no special seasonal test is required and that testing can be executed during any season, if condition simulation is appropriate.

<sup>2</sup>Monitoring testing each tower as lead tower is not necessary.

- E. Special Procedures or Conditions (other equipment to test with, etc.; reference to function ID)
1. Tests to be made with chiller in automatic mode.
  2. False load chiller, if necessary.

F. Required Monitoring

1. All points listed below which are control system monitored points shall be trended by the controls contractor. Other points shall be monitored by the CA using dataloggers. Refer to the Monitoring section at the beginning of Section 15997 for additional monitoring details.

Point	Time Step (min.)	Minimum Time Period of Trend	Hard Copy? (Y/N)	ASCII File? (Y/N)	Function Being Tested
For each CT:					
CDEWT	5	45 days incl. weekend	Y	Y	1, 2, 4, 9
CDLWT	5	45 days incl. weekend	Y	Y	1, 2, 4, 8, 9
OSAT-DB	5	45 days incl. weekend	Y	Y	1, 2, 4, 8,9
OSAT-WB(optional)	5	45 days incl. weekend	Y	Y	8
Fan motor speed, stage or current	5	45 days incl. weekend	Y	Y	4, 9
CDW pump speed or current	5	45 days incl. weekend	Y	Y	1, 2, 4, 9
Each chiller status or current	5	45 days incl. weekend	Y	Y	1, 2, 4, 9

Remarks:

G. Acceptance Criteria (referenced by function or mode ID)

1-12. For the conditions, sequences and modes tested, the cooling tower(s), integral components and related equipment respond to varying loads and changing conditions and parameters appropriately as expected, as specified and according to acceptable operating practice.

5. Cooling tower should be able to maintain the current specified setpoint for entering condenser water to within +/- 2F, when outside conditions do not restrict this thermodynamically.

H. Sampling Strategy for Identical Units

1. No sampling, test all.

3.7 EXAMPLE #6: EXHAUST FANS:

The testing requirements apply to the following fans (check all that apply):  battery room,  mechanical room,  refrigerant exhaust.

A. Parties Responsible to Execute Functional Test

1. Controls contractor: operate the controls to activate the equipment, if BAS controlled.
2. CA: to witness, direct and document testing.

B. Integral Components or Related Equipment Being Tested

Prefunctional Checklist ID

1. Exhaust fans

PC-\_\_\_\_\_

C. Prerequisites: The applicable prerequisite checklist items listed in the beginning of Section 15997 shall be listed on each functional test form and checked off prior to functional testing. The commissioning agent will also spot-check misc. items and calibrations on the prefunctional checklists previously completed by the installer, before the beginning of functional testing.

D. Functions / Modes Required To Be Tested, Test Methods and Seasonal Test Requirements:

The following testing requirements are in addition to and do not replace any testing requirements elsewhere in this Division.

<u>Function / Mode</u>	<u>Test Method</u> Manual, Monitoring, Either or Both <sup>1</sup>	<u>Required</u> <u>Seasonal</u> <u>Test</u>
General 1. Test each sequence in the sequence of operations, and other significant modes and sequences not mentioned; including startup, shutdown, unoccupied & manual modes and power failure. Test functionality of this piece of equipment or system in all control strategies or interlocks that it is associated with.	Manual	
In addition to, or as part of (1) above, the following modes or tests are required:		
2. Verify schedules and setpoints to be reasonable and appropriate		
3. Function at fire alarm (off, depressurization, etc.)	Manual	
4. Interlocks to building pressurization control	Manual	
5. Speed controls	Either	
6. Check TAB report record of sound power level tests and space pressures and compare to specifications	Review	
7. Sensor calibration checks on any controlling temperature or pressure sensor	Manual	

<sup>1</sup>Refer to Special Procedures

E. Special Procedures (other equipment to test with, etc.; reference to function ID)

None

F. Required Monitoring

1. All points listed below which are control system monitored points shall be trended by the controls contractor. Other points shall be monitored by the CA using dataloggers. Refer to the Monitoring section at the beginning of Section 15997 for additional monitoring details.

Point	Time Step (min.)	Minimum Time of Trend	Period	Hard Copy? (Y/N)	ASCII File? (Y/N)	Function Being Tested
For each fan:						
Do be determined						

Remarks:

G. Acceptance Criteria (referenced by function or mode ID)

- 1-6. For the conditions, sequences and modes tested, the fans, integral components and related equipment respond to changing conditions and parameters appropriately as expected, as specified and according to acceptable operating practice.

3.8 EXAMPLE #7: INDOOR AIR CLIMATE CONTROL--MISC. SYSTEMS:

All space zones shall be verified to be maintaining proper climate control. Specific test requirements for this may have been identified elsewhere in this specification (e.g., under terminal units). For all areas not specifically specified, otherwise, the following tests shall be conducted.

A. Parties Responsible to Execute Functional Test

1. Controls contractor: operate the controls and provide trend logs
2. CA: to witness, direct and document testing.

B. Integral Components or Related Equipment Being Tested

1. Building cooling
2. Building heating
3. Air, water or steam distribution system
4. Control system

C. Prerequisites All listed systems in Part B, above, shall have had successful functional tests completed prior to this test.

D. Functions / Modes Required To Be Tested, Test Methods and Seasonal Test Requirements

This is a performance test to verify that the HVAC systems can provide and maintain the temperature and relative humidity levels specified, during normal and extreme weather and occupancy conditions. The test consists of monitoring, via trend logs, of various points during the cooling season when temperatures reach to within 5°F of season design (ASHRAE 2 1/2%).

E. Special Procedures (other equipment to test with, etc.; reference to function ID)

1. Plant equipment shall be in operation during the test.

F. Required Monitoring

1. All points listed below which are control system monitored points shall be trended by the controls contractor. Refer to the Monitoring section at the beginning of Section 15997 for additional monitoring details.

Point	Time Step (min.)	Minimum Time Period of Trend	Hard Copy? (Y/N)	ASCII File? (Y/N)	Function Being Tested
Space temperature control:					
Space temperature	5	5 days incl. weekend	Y	Y	1-3
OSAT-DB	5	5 days incl. weekend	Y	Y	1-3

Remarks:

- G. Acceptance Criteria (referenced by function or mode ID)
  - 1. Space temperature during occupied modes shall average within +/- 1°F of setpoint and always remain within 1°F of the ends of the deadband without excessive hunting of either the applicable damper or coil valve, or complaints of drafts or stuffiness from occupants.

3.9. EXAMPLE #8: TERMINAL UNITS:

(This applies to standard applications, critical applications will have additional tests and a higher fraction tested.)

- A. Parties Responsible to Execute Functional Test
  - 1. Controls contractor: operate the controls to activate the equipment.
- B. Integral Components or Related Equipment Being Tested Prefunctional Checklist ID
  - 1. Fan coils PC-\_\_\_\_\_
- C. Prerequisites The applicable prerequisite checklist items listed in the beginning of Section 15997 shall be listed on each functional test form and checked off prior to functional testing. The commissioning agent will also spot-check misc. items and calibrations on the prefunctional checklists previously completed by the installer, before the beginning of functional testing.
- D. Functions / Modes Required To Be Tested, Test Methods and Seasonal Test Requirements

The following testing requirements are in addition to and do not replace any testing requirements elsewhere in this Division.

<u>Function / Mode</u>	<u>Test Method</u> Manual, Monitoring, Either or Both <sup>3</sup>	<u>Required</u> <u>Seasonal</u> <u>Test</u> <sup>1</sup>
General 1. Test each sequence in the sequence of operations, and other significant modes and sequences not mentioned; including startup, warmup, shutdown, unoccupied & manual modes and power failure and restoration. Test functionality of this piece of equipment or system in all control strategies or interlocks that it is associated with, including all damper, valve and fan functions.	Manual	
In addition to, or as part of (1) above, the following modes or tests are required:		
2. Sensor activator calibration checks on: SAT, MAT, zone air temperature damper position and other random checks (EMS readout against visual or hand-held calibrated instrument must be within 0.5°F for temps. or within a tolerance equal to 10% of static pressure setpoint, with an inclined manometer)	Manual	
3. Device and actuator calibration and stroke checks for heating coil valve and cooling coil valve	Manual	
4. For the TU's tested, check the prefunctional checklist items.	Observation	
5. Verify control parameters and setpoints to be reasonable and appropriate by reviewing the full program of all the TU's with each other for consistency.	Observation	
6. Verify no CCV flow when there is HCV flow	Either	
7. Verify no hunting or significant overshoot by damper or valves.	Either	
8. Verify by measurement, CCV & HCV positive shutoff (no leak-thru)	Manual	
9. All alarms (fan status, low limits, high static, etc.)	Manual	
10. Verify that TU is maintaining space setpoint temperatures	Monitoring	Both Design
11. Verify airflows and pressures (this random test is part of the TAB test)	--	

NOTES:

<sup>1</sup>Cooling season, Heating season or Both. "Design" means within 5°F of season design (ASHRAE 2 1/2%), or 95% of loading design. A blank cell denotes no special seasonal test is required and that test can be executed during any season, if condition simulation is appropriate.

<sup>2</sup>Seasonal test not required if seasonal conditions can be adequately simulated.

<sup>3</sup>Refer to Special Procedures

E. Special Procedures (other equipment to test with, etc.; reference to function ID)

None

F. Required Monitoring

1. All points listed below which are control system monitored points shall be trended by the controls contractor. Other points shall be monitored by the CA using dataloggers. Refer to the Monitoring section at the beginning of Section 15997 for additional monitoring details.

Point	Time Step (min.)	Minimum Time Period of Trend	Hard Copy? (Y/N)	ASCII File? (Y/N)	Function Being Tested
For each zone thermostat and space sensor and other critical areas, monitor:					
Space temperature	10	5 weekdays incl. weekend	Y	Y	11
Space temperature	10	5 weekdays incl. weekend	Y	Y	11
Space temperature	2	5 weekdays incl. weekend	Y	Y	7
Heating coil valve	2	5 weekdays incl. weekend	Y	Y	7
Damper position or cfm	2	5 weekdays incl. weekend	Y	Y	7

Remarks:

G. Acceptance Criteria (referenced by function or mode ID)

1-11. For the conditions, sequences and modes tested, the TU, integral components and related equipment respond to varying loads and changing conditions and parameters appropriately as expected, as specified and according to acceptable operating practice.

10. Space temperature during occupied modes shall average within +/- 1°F of setpoint and always remain within 1°F of the ends of the deadband without excessive hunting of either the damper or coil valve, or complaints of drafts or stuffiness from occupants.

END OF SECTION



## DIVISION 16-ELECTRICAL

### SECTION 16010 BASIC ELECTRIC METHODS AND REQUIREMENTS

#### PART 1 - General

Meet all of the requirements of the National Electrical Code (NEC), the New Mexico State Electrical Code, the National Electrical Safety Code (NESC) and Underwriters Laboratories (UL).

- A. Fabrication, erection and installation of the complete electrical system shall be done in a first-class workmanlike manner by qualified personnel experienced in such work and shall proceed in an orderly manner so as not to hold up progress of the project. The Contractor shall have a current New Mexico EL-1 (over 1000 volts electrical contractor's license) to do medium voltage work or current New Mexico EE-98 (under 1000 volts electrical contractors license) to do low voltage work. Shall meet all requirements of the University of New Mexico and have a 3-M or Elastimold certification to do medium voltage termination and splicing of medium voltage cable. The journeyman electrician doing the over 1000 volts work shall have the JE-L1 license and the journeyman electrician doing the under 1000 volts work shall have the JE-98 license. The Contractor shall check all areas and surfaces where electrical equipment material is to be installed, removed or relocated and report any unsatisfactory conditions before starting work. Commencement of work signifies this Contractor's acceptance of existing conditions. In the acceptance or rejection of the finished installation, no allowance will be made for lack of skill on the part of workmen.
- B. Secure permits and inspections from New Mexico Construction Industries Division (CID).
- C. Provide submittals for all major equipment and as requested by the owner.
- D. Contractor shall visit the site and examine existing conditions prior to submitting a proposal.
- E. Coordinate power and other utility outages with the Physical Plant. Work will be done at premium time required by the owner.
- F. Materials and workmanship shall be warranted for one year after the date of final acceptance. 15KV cable shall have a manufacturer's 40-year warranty.
- G. Confine operations at the site to the areas permitted under the Contract. Portions of the site beyond areas on which work is indicated are not to be disturbed.
- H. The Owner will occupy the site and all buildings affected by construction, during the entire construction period. Cooperate with the Owner during construction operations to minimize conflicts and facilitate Owner usage. Perform the work so as not to interfere with the Owner's operations.

- I. A mutually agreeable schedule for this work will be developed at a later date. Some premium time may be required.

## PART 2 - Special Conditions

- A. The electrical drawings show the general arrangement of all conduits, equipment, etc. and shall be followed, as closely as actual building construction and the work of other trades will permit. The architectural and structural drawings shall be considered as a part of the work insofar as these drawings furnish the contractor with information relating to the design and construction of the building. Architectural drawings shall take precedence over electrical drawings. The contractor shall investigate the structural and finish conditions affecting the work and shall arrange his work accordingly, providing such fittings, elbows, pullboxes and accessories as a may be required to meet such conditions.
- B. Field measurements: The Contractor shall verify the dimensions governing the electrical work at the site.
- C. These special conditions notes, other notes on the drawings and the project manual shall be considered complimentary. If a conflict exists, the most strict, restrictive and demanding requirement shall apply, based on a determination by the Owner's representative.
- D. Contractors shall have unlimited (UNM accompanied) access to campus facilities related to this project for purposes of preparing bids and ultimately performing the work. Prior scheduling is required and may be arranged by contacting Ford Utilities at 277-1144. By submitting a bid on this project, the contractor confirms that the site has been visited, that existing conditions have been considered and that the Contractor has included all costs for all work indicated on the documents and in the project manual.
- E. Excavation debris, materials, any type of rubbish, etc., shall not be allowed to accumulate at any construction site. All debris, such as concrete, paving, bushes, trees, garbage, etc. shall be removed daily. Earth that is intended for use as backfill must be safely stockpiled, for a limited time only, along the path of the ductbank inside the construction fence. The campus is very congested and students, faculty and visitors must be provided safe and clear access. Therefore, compliance with this requirement is very important.
- F. All work areas shall be entirely fenced off with not less than 7-foot high chain link fencing panels, or equivalent, firmly fastened to the ground. Flashing safety lighting for fenced areas and all construction sites shall be provided for night periods. Safety is paramount.
- G. All applicable UNM rules and regulations apply to this project. All applicable city, state and county codes, ordinances, rules, etc. also apply.
- H. The contractor is responsible for "spotting" all existing underground utilities that will be in the path of his work and avoiding damage to same. Buried utilities exist all along the path of work. UNM will make available to the contractor all the latest underground utility information that is available. Most notably a recent set of JMA & Associates utility mapping drawings. These drawings

along with access to buildings and the tunnel utilities shall also provide information for the contractor's use. Any and all damage to existing utilities shall immediately be properly repaired/restored at no cost to UNM.

- I.** The contractor must anticipate that parking spaces will be blocked and/or used during construction for installation of ductbank. This must be kept to a minimum. The Contractor shall pay parking services for any and all spaces that are blocked for construction and are not useable. Parking spaces and access to the spaces must be restored immediately after work is complete. This payment is Parking Department policy. The fee is \$4.00 per day per space. No charge for weekends.
- J.** It must be anticipated and expected that some work may be required after hours and on weekends. This will be kept to a minimum. No extra cost for after hour's work will be recognized. All power outages shall be on weekends or as approved by the Owner.
- K.** Some of the work will require electrical outages to campus buildings and will usually occur after hours and on weekends. If any outage requires that any building be without power for more than three hours, temporary power in the form of generators must be provided.
- L.** As part of this contract, the Contractor shall provide a complete marked-up set of contract documents, including all changes to the documents during the project construction phase to the Architect.
- M.** The electrical requirements for equipment indicated on the drawings are based on information available at the time of the design. The Contractor shall check the electrical requirements for all equipment to be furnished under this contract and determine if any adjustments to wire and conduit size, controls, overcurrent protection, and installation are required to accommodate the equipment supplied. Changes required because of substitution in materials provided will be made at the Contractor's expense. The contractor shall provide all raceways and conductors as required for connection of mechanical equipment and controls.
- N.** All outages will be scheduled with and approved by the Owner in advance. In each case, provide written schedules to Owner two weeks prior to outages.
- O.** Reasonable staging area(s) will be provided for the Contractors on-site storage of construction materials, but they must be fenced and restored after use. It must be expected that the staging areas will not be adjacent to the work site. Moving materials and equipment to the site must be expected. Workers' vehicles cannot be parked in the staging areas, only limited construction work vehicles will be allowed. The Contractor shall make necessary arrangements for workers remote parking at no additional expense to UNM.
- P.** The Contractor shall maintain safe vehicular and pedestrian access at all times to all campus facilities, including all parking lots and buildings. Necessary bridges, fencing, etc. shall be provided. Work in one lane of the road or parking lot at any one time so as to allow vehicular access. Crossing of roads or thoroughfares shall be done half at a time. Also note that Fire Department and other emergency access is required at all times. The Owner's representative

shall approve all access plans. Standard approved traffic signs are required. Other signs directing pedestrian or vehicular traffic shall be provided as required by the Owner.

- Q.** Reasonable water and 120 volt power is available at no charge, in or near the buildings for Contractor's use. The Contractor shall supply all required hoses, extension cords, wiring, fittings, etc. that are required. Any expenses associated with connecting to these utilities shall be born by the Contractor. Coordinate arrangements with the Owner's representative.
- R.** The Contractor shall prepare a formal detailed phasing and sequence of construction plan prior to commencement of work. This plan must consider the amount of work (trench opening) that can be done at one time, availability of materials, and project substantial completion. A bar chart is acceptable but must be specific and indicate a critical path.
- S.** The Owner shall order and pay for soil compaction tests. The earth subgrade under the ductbank and backfill shall be compacted to 95% minimum per ASSHTO. Backfill lifts shall not exceed 8" between compaction efforts. Anticipate that the Owner will order random compaction tests. Failure to attain acceptable compaction will result in the Contractor performing all required work to attain proper compaction. The Contractor shall pay for all re-tests.
- T.** If deemed necessary by UNM or if deemed expedient by the Contractor, approved steel plates shall be used over roadways or other traffic areas either for safety reasons, access reasons or to facilitate work or to allow safe passage of traffic.
- U.** Verify the electrical requirements for any equipment to be connected, whether existing, furnished under this contract or by others, prior to ordering materials or roughing in.
- V.** Remove completely all abandoned or unused electrical equipment associated with this work. Dispose of or salvage as directed by the Owner. Use all means to protect electrical materials and equipment before, during and after installation.
- W.** Coordinate connection and energization of the new feeder with the Owner; provide written procedures for the Owner's approval.
- X.** All above ground switches, transformers, etc. shall be factory painted an approved beige color. Switches, if not provided by PPD Utilities, shall be Powell Esco approved by the Chief Electrician.

### PART 3 - Site Work

- A.** This project will destroy existing surface finishes/features, facilities, landscaping, etc. In every case, any and all disturbed surfaces must be restored to match or exceed existing conditions. In order to avoid conflict during the restoration stages of work, the Contractor shall take a series of adequate color photographs that are sequentially labeled, identified and filed so as to define the existing conditions. Failure to have current photographs will subject the Contractor to performing restoration work as reasonably directed by

the Owner's representative. Generally, the surface and surface features shall be restored to match/duplicate within reason, color, size, texture, materials, thickness, etc. of the existing surface.

- B.** New trees shall be the same variety as the tree that was removed for the installation. The size of trees provided will be based on the removed tree diameter, total diameter of new trees to reasonably match the existing tree diameter on a one to one basis.
- C.** Shrubs shall generally match the quantity, size and type of that which was removed.
- D.** Grass areas shall be sodden with material matching existing. The subsurface shall be properly prepared and approved prior to installing sod.
- E.** Asphalt paving shall be neatly saw cut as per specification. If the "paved" trench is within 30" of another joint, edge, insert, etc., paving shall be removed to that point and replaced. No small isolated paved areas shall be left to remain. Replaced paving shall match the existing in thickness, texture, etc. The vertical edges and subbase shall be tack coated prior to patching. The top edge/cold joint shall have hot tack/sealer (AC) applied. Restoration of parking lot striping and other markings shall be restored as well.
- F.** Concrete paving and sidewalks shall be replaced in full panel sizes. Remove existing concrete to the nearest joint, score or edge. Straight saw cut edges are required. Random cuts or patches will not be allowed. The existing pattern must be restored. Replaced concrete shall reasonably match the existing in thickness, texture, reinforcing, color, etc. except where City of Albuquerque standards exceed existing (i.e. strength, thickness, reinforcing, etc.) which takes precedence.
- G.** Other paving (brick, pavers, etc.) shall be replaced to match the existing in every way.
- H.** Grading shall be restored to match existing or modified to provide proper drainage without causing tripping hazards.
- I.** Proper fertilization and mulching will be required where determined to be necessary for proper growth of new materials.
- J.** All disturbed irrigation lines, heads, control valves and boxes shall be restored to existing condition. UNM assistance is offered so as to shut off irrigation prior to disturbance.
- K.** It is in the Contractor's best interest to consult with UNM prior to disturbing any surface to be sure of the restoration requirements before proceeding with each phase of work. The Owner's representative shall be the final authority in determining satisfactory restoration. Restoration shall be done on an on-going basis, as work progresses and not left to the end of the job.
- L.** Backfill excavations as promptly as work permits, but not until completion of the following: inspection, testing, approval, and locations of underground utilities have been recorded, removal of concrete formwork, shoring and bracing, and removal of trash and debris.

- M.** Before compaction, moisten or aerate each layer as necessary to provide optimum moisture content. Compact each layer to required percentage of maximum dry density or relative dry density for each area classification specified below. Do not place backfill or fill material on surfaces that are muddy, frozen, or contain frost or ice.
- N.** Place backfill and fill materials in layers of not more than 8 inches in loose depth for material compacted by heavy equipment, and not more than 4 inches in loose depth for material compacted by hand-operated tampers.
- O.** Place backfill and fill materials evenly adjacent to structures, piping, and equipment to required elevations. Prevent displacement of raceways and equipment by carrying material uniformly around them to approximately same elevation in each lift.
- P.** Compaction shall meet or exceed 95% relative density in accordance with ASTM D 2049.
- Q.** Subsidence: Where subsidence occurs at electrical installation excavations during the period 12 months after Substantial Completion, remove surface treatment (i.e., pavement, lawn or other finish), add backfill material, compact to specified conditions, and replace surface treatment. Restore appearance, quality, and condition of surface or finish to match adjacent areas.

END OF SECTION

SECTION 16015  
ELECTRIC WORK

PART 1 - General

- A. Shop Drawings: Submit 5 copies of shop drawings for all materials and equipment and approval in a timely manner, and prior to ordering any materials. Include catalog data sheets, complete dimensions, electrical data, control diagrams, and other pertinent data required for installation. Submit shop drawings for the following applicable items: lighting fixtures, panelboards, medium voltage switches, transformers, 15 KV cable, 600 volt cable, main distribution centers, conduit, duct, etc.
- B. Use materials as specified or approved by the Owner. Where no manufacturer is specified, a first-class product of a reputable manufacturer shall be used, provided that it meets the intent of the contract documents and is approved. All materials and equipment shall be the standard products of manufacturers regularly engaged in the production of such material and shall be the manufacturer's current and standard design.
- C. As-built drawings: during progress of the work, maintain an accurate record of the installation of the system, locating each circuit precisely by dimension. Upon completion of the installation, provide accurate AutoCAD drawings to the Owner on disks, original drawings and blueprints. Coordinate with the General Conditions and the General Requirements of these specifications. As-built drawings for the ductbank will include centerline dimensions from the center of the tunnel and will also include a depth dimension (surface to the top of the ductbank) every fifty feet.
- D. Operating instructions and manuals: Upon completion of the work, prepare and deliver to the Owner three (3) sets of complete operating and maintenance manuals for the systems and major equipment installed. Include catalog data, shop drawings, wiring diagrams, performance curves and rating data, spare parts lists and manufacturer's operating and maintenance data.
- E. Without additional charge to the Owner, furnish competent instruction to the Owner in the care, adjustment and operation of all parts of the electrical equipment and systems.
- F. Location of new primary feeders is schematic in nature. The drawings show the proposed routing, general location of new manholes, underground ductbanks, etc. Final routing of conduits and equipment shall be determined from actual field conditions and shall be coordinated with the Owner's commencement of construction, proposed routing of the ductbanks. Provide sketches to the Owner.

END OF SECTION

SECTION 16050  
ELECTRICAL COMMISSIONING

The Contractor shall engage the services of a qualified local (respond within a four hour time period) independent testing agency that is certified by the International Testing Association (NETA), including all material, equipment, labor, and technical supervision to perform such tests and inspections. The independent testing agency shall perform all tests and shall certify in writing to the Owner that all testing and inspection requirements in this specification section have been met including submitting all reports required herein. Relay coordination, arc flash study, and labeling is to be included. It is the purpose of these specifications to assure that all tested electrical equipment, both Contractor-and Owner-supplied, is operational and within industry and manufacturer's tolerances and is installed in accordance with design specifications. The tests and inspections shall determine suitability for energizing. An itemized description of equipment to be inspected and test includes:

1. Medium-voltage cable, 15 kV (test voltage 55,000 VDC)
2. Grounding systems (not more than 5 ohms)
3. Medium-voltage switches and relays
4. Pad mounted transformers
5. Low voltage equipment.

Thoroughly test all fixtures, services and all circuits for proper operating conditions and freedom from grounds and short circuits before acceptance is requested. All equipment, appliances and devices shall be operated under load conditions. Furnish all instruments and labor required for testing. All test shall be done to NETA Acceptance testing Specification, current addition.

END OF SECTION



## SECTION 16110

### DUCTBANK

1. The depth of excavation for the ductbank and manholes will vary depending on existing utilities and the necessity to install the ductbank under the UNM utility tunnel. The Contractor shall anticipate that some excavation will be deep and shall include all excavation costs in the bid. Depth of the tunnel footings can exceed ten feet below grade. Some modification to ductbank configuration will be considered so long as code allows and when approved by the Owner's representative consideration will also be given to relocating existing utilities in lieu of excessive excavation when approved by the Owner's representative.
2. The vertical excavation of the ductbank will have to vary but the vertical and horizontal offset shall not exceed 22 degrees and must run flat for not less than 15 feet before a second offset in any direction is constructed. Offsets shall be limited so as to limit cable-pulling pressure/force. Also manholes located near the tunnel or "deep" obstructions shall be set deeper so as to limit conduit bends and offsets and thereby limit cable pulling tension and sidewall pressure. The design limits conduit bends to a total of 270 degrees between manholes. If this is exceeded due to the Contractor's plan for work he shall provide additional approved manhole pull boxes at no extra cost to the Owner.
3. Generally, it is desirable that the ductbank be installed at least five (5) feet away from the exterior tunnel wall. This is to provide for future utility piping exiting from the tunnel. It is understood that this spacing cannot be maintained throughout but when possible, it is expected.
4. Trench excavation/opening shall be limited to an agreed-to length, not exceeding 300 feet. The expectation is that only that quantity of trench will be opened in which work can be reasonably completed in two to three days. It is understood that work in the area of manholes will take longer and isolated work locations such as this may remain open longer, but not too much longer and must be entirely fenced-in. Excessive trench opening and the associated safety hazards and danger shall be avoided. Also, all trenches shall be fenced all around and the quantity of fencing available will limit the length of open trench. The Contractor's construction schedule will necessarily reflect the above. As soon as reasonable backfill shall be completed, excess earth hauled away and the fencing removed.
5. The Owner's representative shall approve the location of each manhole (and pull boxes in switching station) and cover are located in the best possible location. Slight location adjustments are to be expected. Locate each rim in one type of surface, not partially in two or more types of surfaces. Manhole rims shall be surrounded by a square concrete collar, 6" thick with a minimum plan dimension equal to the largest rim width dimension plus two (2) feet. #3 rebar on 6" centers all around and diagonal at the corners will be provided in the concrete collars.
6. Sufficient trench between manholes and termination points shall be opened before any conduit is installed in order to determine if any obstructions exist. All existing utility line crossings are to be verified and hand excavated. Install duct bank minimum 42" below grade, to top of duct bank.
7. Duct banks shall have conduit joints and couplings staggered at least six inches horizontally.

8. Spacers shall be used where more than one duct is installed and shall be the standard product of the duct manufacturer for the type and size duct. They shall be located at five-foot intervals, secured to the ducts with 316-gauge iron wire. The spacers shall be securely anchored to the bottom of the trench to prevent ducts from floating during concrete pouring. Unless otherwise noted on the drawings, four-inch conduit shall have a minimum eight-inch spacing center-to-center and 5" conduits shall have a minimum of 10" spacing center-to-center.
9. Continuous vibrating of concrete during pouring shall be performed to ensure complete coverage between and under ducts to eliminate voids. Mechanical vibrator shall be used.
10. Terminate conduits in an end bell at manhole penetrations. Stub-ups of rigid or IMC duct in equipment pads shall have threaded insulated grounding bushing.
11. Apply corrosion protection tape, half lapped, to non-PVC-coated underground metallic conduit and fittings that are in direct contact with earth and concrete only. Ground as required by the NEC.
  - 1) Conduit and duct runs shall be as short and straight as possible between points of the system. Bends shall be laid out with the greatest possible radius.
  - 2) Duct runs shall be graded to drain toward one or both terminal points of the duct run. The slope shall not be less than two inches for every 100 feet of length. Where termination points are at manholes or any other structure, provide proper drainage where low points in duct runs cannot be avoided.
  - 3) When ducts enter a manhole, buildings, and utility tunnel, reinforce as indicated on the drawings to prevent shear stress on the conduit.
  - 4) Empty ducts shall have a ¼" polypropylene rope provided with two feet of slack at each end with both ends secured.
  - 5) Conduit or duct banks shall maintain one-foot vertical and one foot horizontal separation from other utility lines where possible.
  - 6) A warning tape shall be installed 12" above the duct bank. The warning tape shall be of inert plastic film 4 mils thick specifically formulated for prolonged use underground, resistant to alkalis and acids found in soils. The tape shall bear a continuously printed message repeated every 36". The tape shall be Terra Tape Standard 250 manufactured by Reed Industries, Inc., or approved equal.
  - 7) A mandrel ¼" – 3/8" smaller than the conduit shall be pulled through each conduit. A circular wire brush the same diameter of the conduit shall be pulled through the conduit after the installation is complete.
  - 8) Conduit stub-outs shall be RGS with threaded metallic caps. Stub-outs shall be capped and not encased in concrete for future accessibility. Capping shall prevent moisture or debris from entering the duct system.

- 9) Concrete encased duct banks installed in traffic areas and roadways shall be suitable for heavy traffic loading. Provide minimum 12" concrete cover in all vehicular traffic areas. Reinforce as detailed.
- 10) Under tunnel crossings must be approached with special care. The ductbank must be reinforced. When crossing under any tunnel at approximately a 90 degree angle (perpendicular to tunnel), the excavation must take place in the middle/between existing tunnel construction joints, must be as narrow as possible, must be completed as fast as possible and must not have any load imposed on the tunnel section. When crossing any tunnel at less than a 60 degree angle, the excavation must take place in the middle/between existing tunnel construction joints, must cross only half-way at a time, must be as narrow as possible, must be completed as fast as possible and must not have any load imposed on the tunnel section. In effect, only one tunnel strip footing will be undermined at a time and only mid-way across the tunnel. The first half must be restored and adequately underpinned before the second half may be started. Specifically obtain owner's approval before starting any tunnel crossing work.
- 11) Wherever shoring is used, it is expected that concrete forms will be used as well so that the shoring can be removed after the concrete is placed. It will not be acceptable to pull the shoring prior to concrete placement. The bottom of the trench must be clear of loose earth and must be compacted to 95%.
- 12) Ductbanks shall be reinforced when crossing roadways, parking lots, large pipes, underground structures, over, and under tunnels. Reinforcing shall extend five feet beyond the edge of the structure or tunnel. Reinforcing shall consist of four longitudinal #4 rebars, one in each corner and #3 rebar non-continuous stirrups on 12" centers, all tied into place. A minimum of 2" of concrete cover is required. Depending on the size of the ductbank, additional reinforcing may be required. See drawings.
- 13) 3000-PSI concrete shall be used for the ductbank encasement. A slump of not more than four inches is acceptable. Concrete shall be mechanically vibrated into place. Exposed concrete shall be air entrained.

## SECTION 16120

### MANHOLES

1. Manholes shall be concrete. Manholes shall meet applicable standards of ASTM C857, ASTM C858, and ANSI C2. Submit drawings on manholes for approval including location of: duct entries, non-load junction modules, pulling irons, lifting eyes (if applicable) sump, manhole covers, etc.
2. Precast concrete manhole manufacturers shall have documented experience in the manufacture of manholes for a minimum of three years. Submittals for the pre-cast manhole shall bear the stamp of a registered professional engineer. The submittal drawing must show the ASTM load designation, the % increases in live load for impact and the working load of the pulling irons. The weight of each portion of the manhole must be shown
3. Base course material under each manhole shall be sand or gravel, three inches minimum compacted 95%.
4. Precast concrete shall be air-entrained, 4000 PSI minimum compressive strength at 28 days.
5. Manhole shape and dimensions shall be specified.
6. Unless otherwise indicated provide two (2) 2-foot square diameter knockouts on each wall.
7. Ram-Nek, Kent seal or approved equal sealants shall be used to seal the joints in the manhole and rim to manhole cover.
8. Provide four (4)-lifting eyes in the top half and eight (8) lifting eyes on the sides of the bottom half of each manhole. Also, provide four (4)-lifting eyes at intermediate sections where applicable. Lifting eyes shall be in accordance with ASTM C857.
9. Manhole accessories shall be as follows:
  - a. Electric manhole frames and covers: ASTM A48, Class 30B gray cast iron, machine finished with flat bearing surfaces. Covers shall be 38" round and shall have "HIGH VOLTAGE 12.47 KV MH# \_\_\_\_\_ cast into the cover. Letter shall be minimum 2" high. Refer to the drawings for manhole numbers. CKT# shall be on a brass tag attached to the lid. Ring and lid shall be "NEENAH" #R-1640D or approved equal.
  - b. Sump Covers: ASTM A48, Class 30B gray cast iron, 12" x 12".
  - c. Pulling irons shall be minimum 7/8-inch diameter steel bar forming a triangle of 9 inches per side when set. Galvanize to ANSI/ASTM A153 for irregular shaped articles. Locate opposite each duct entry. Pulling irons shall be designed for a working load of 5,000-lbs. minimum with a safety factor of 2. Provide minimum of eight (8)-pulling irons in the bottom of the manhole and a minimum of four (4) pulling irons in the top half of the manhole.
  - d. Cable Rack Inserts: Steel channel insert with minimum load rating of 800 pounds, length to match cable rack channel. Locate 3 feet on centers.
  - e. Cable Rack Channel: 1-1/2 by 3/4 inch steel channel wall bracket, 48" length, with cable rack arm mounting slots on 1-1/2" centers.

- f. Cable Racks: ANSI/ASTM A569, steel channel, 1-1/2 by 3/4 x 14 inches with fiberglass reinforced polyester or porcelain cable supports and fastener to match mounting channel.
- g. Manhole Ladder: Insulated or metal, suitable for manhole shape and construction. Primed and painted light gray. Bolt into place. The top of the ladder should extend to two inches below the manhole cover.
- h. The exterior of the manhole shall be waterproofed with a coating of bitumastic or asphalt material such as Koppers 300M or approved equal.
- i. Ground rods shall be 3/4" by 10'-0" long, copperweld. (2 per manhole)
- j. Grade Rings: Pre-cast concrete (4000-psi minimum compressive strength at 28 days) with inside diameter equivalent to manhole opening. The ring shall have circumferential rebar #3 minimum with a trowel finish to provide a true plane with 1/8 inch, as determined with a five-foot straight edge. Waterproof around the ring and C1 frame with roofing element.
- k. All manhole interiors shall be painted flat white with two (2) coats of concrete paint.
- l. All manholes shall be rated for traffic duty per AASHTO HS-20-44, including manhole and cover.
- m. Cast in place concrete manholes will be acceptable. Construction drawings need to be approved.

## SECTION 16121

### GROUNDING AND INSTALLATION METHODS

- A. General: Provide a complete equipment grounding system in accordance with the minimum code requirements. The equipment ground (green conductor) consists of metallic connections to grounds of non-current carrying metal parts of the wiring system or apparatus connected to the system.
- 1) Service Equipment Enclosure: Bond the enclosure of the main service equipment to the uninsulated equipment ground bus (or bar) with a conductor or bar sized for 50% of the largest service overcurrent device.
  - 2) Ground Bar: Provide an uninsulated equipment ground bar, separate from any insulated neutral bar, in all switchboards, panelboards, transformers, motor control centers, starters, disconnect switches, cabinets, etc., for grounding the enclosure and for connecting other equipment ground conductors. The ground bar shall be an integrally mounted and braced bus bar in switchboards or a separately mounted bar adequately braced or bolted at the enclosure of other types of equipment. The ground bar shall be adequately braced or bolted to the enclosure after thoroughly cleaning both surfaces to assure good contact. Provide solderless pressure connectors for all conductor terminations. Number and size of pressure connectors on equipment grounding bars as required for the termination of equipment grounding conductors. In addition to the active circuits, provide pressure connectors for all three-phase spares and spaces.
  - 3) Conduits: Where metallic conduits terminate without mechanical connection to a metallic housing of electrical equipment by means of lock nut and bushings, provide ground bushing connected with a bare copper conductor to the ground bar in the electrical equipment. Metallic conduits containing ground wiring shall be bonded to the ground wire at both conduit entrance and exit. Install grounding conductor in all conduit or duct. Bond the conductor at both ends to the equipment grounding system.
  - 4) Feeders and Branch Circuits: Provide a separate green insulated equipment-grounding conductor all circuits. Provide a separate green insulated equipment grounding conductor for single phase branch circuits where indicated on the drawings. Install the required grounding conductor in the common conduit or raceway with the related phase and/or neutral conductors and connect to the box or cabinet-grounding terminal. Where there are parallel feeders installed in more than one raceway, each raceway shall have a green insulated equipment ground conductor.
  - 5) The grounding conductors for both service ground electrodes shall be insulated or bare copper, sized as shown on the drawings; otherwise size in accordance with NEC 250-94(a), including the conductor for the made electrode. The conductors shall be continuous without joint or splice and shall be installed in conduit with the conduit bonded to the conductor at each end. Install the conductor to permit the shortest and most direct path and terminate in the main service equipment on the common ground point. Equipment grounding conductors shall be green insulated conductors equivalent to the insulation on the associated phase conductor, but not less than Type THHN/THWN. The equipment grounding conductor or straps shall be sized in accordance with

NEC. Where one feeder serves a series of panelboards or transformers, the equipment grounding conductor shall be continuous without splices. Ground conductors shall not be installed through metal-sheathed holes. All connections shall be available for inspection and maintenance.

- 6) Clean surfaces thoroughly before applying ground lugs or clamps. If surface is coated the coating must be removed down to the bare metal. After the coating has been removed, apply a non-corrosive approved compound to cleaned surface and install lugs or clamps. Where galvanizing is removed from metal, it shall be painted or touched up with "Galvanox", or equal.
- 7) Provide new ¾ inch by 10 foot 0 inches copperclad ground rods at all manholes. At existing transformer pads (where applicable), provide ground rods and new #4/0 BSD (copper) grounding conductor and bond to transformer frame, ground rod, 15kv cable ground shields, and secondary cable grounding conductors. Provide new threaded grounding bushing on new and/or existing primary conduits and existing secondary conduits and bond to the grounding conductor. Splices between new and existing grounding conductors shall perform utilizing exothermic weld process (**split bolt type connectors will not be accepted for grounding connections**).
- 8) Grounding for surge arresters shall extend from the surge arrester directly to the grounding conductor (do not loop ground down and then up).
- 9) Do not allow the grounding conductor to come into contact with concrete. Provide sleeves as needed.
- 10) Install a counterpoise grounding system (4/0 + not lengthen 4 ground rods) around all equipment pads and supports.
- 11) Provide a base 4/0 copper ground in ductbank as specified in the ductbank section.

B. Medium Voltage Cables (15KV)

- 1) All cable furnished under this contract shall be the product of a single manufacturer and shall be purchased within twelve (12) months of the manufacture date of the cable. Labeling of cable shall be NEMA and ICEA requirements and shall contain the name of the manufacturer and the NEC Designation (MV-105). **Cable patches and any other cable repair will not be accepted.**
- 2) 15KV cable shall operate at 60HZ, three phase on a 7200/12470 volt system.
- 3) The cable shall be manufactured in accordance with the latest revisions of the applicable specifications of AEIC, ASTM, ICEA, and REA except where they conflict with these specifications in which case this specification shall apply.
- 4) The Contractor shall warrant all cable splices and terminations for a period of one (1) year. In the event of fault considered to be related to improper workmanship or premature failure of cable, splices, or terminations, it shall be the responsibility of the Contractor to replace equipment, cable and connections at no additional cost to the Owner. All cable shall have a forty- (40) year

warranty from the cable manufacturer. The warranty shall cover full replacement of the entire length of the faulted cable (if installed in a three phase system, all three conductors shall be replaced). Warranty shall cover all material and labor cost to change out cable. The warranty, written on the cable manufacturer's letterhead and signed by a senior representative with signature authority must accompany the submittals for proper evaluation. **No submittals without this warranty will be considered.**

- 5) Deliver medium-voltage cable on factory reels complying with NEMA WC 26.
- 6) Store cables on reels on elevated platforms in a dry location.
- 7) Assure cable in storage is properly end-capped to prevent entry of moisture.
- 8) Cable Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated in the Work include and are limited to the following: The Okonite Co., Power Cable Division, Pirelli Cable Corp., Rome Cable Corp., and BICC General.
- 9) Cable shall be type: MV105, Conductor: Annealed uncoated copper compact stranded per ASTM B-496, Conductor Shield: Extruded semiconducting Ethylene-propylene rubber (EPR) per AEIC CS6, and Insulation: EPR complying with AEIC CS6, Voltage ratings: 15 KV, Insulation Thickness: 133 percent insulation level, Insulation Shield: Extruded EPR per AEIC CS6, Shielding: 5 mil copper tape with minimum 12-1/2% overlap, helically applied over semiconducting insulation shield; Jacket: Sunlight-resistant PVC.
- 10) Provide maximum 15kv-cable slack in all manholes, etc. 15 kv cable shall be wrapped at least one and one half times around the circumference of all manhole interiors and properly supported.
- 11) Install medium-voltage cable according to manufacturer's written instructions and IEEE 576.
- 12) Pull conductors simultaneously where more than one cable is indicated in same raceway. Use NRTL-listed and manufacturer-approved pulling compound or lubricant where necessary. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
- 13) Use pulling means including fish tape, cable, rope, and basket-weave wire/cable grips that will not damage cables or raceways. Do not use rope hitches for pulling attachment to cable. Puller shall indicate actual pulling tension.
- 14) Install exposed cable parallel and perpendicular to surfaces of exposed structural members and follow surface contours where possible.
- 15) In manholes, handholes, pull boxes, junction boxes, and cable vaults, train cables around walls by the longest route from entry to exit and support cables at intervals adequate to prevent sag.
- 16) Fireproof cables and splices in manholes: apply one layer of half-lapped fireproofing tape; extend fireproofing one inch into ducts; extend fireproofing



one inch into connector bodies and terminations; bind fireproofing tape in place with glass tape; fireproofing shall be 3M® product 77 or equal.

- 17) Install terminations at ends of conductors with standard kits. Conform to manufacturers written instructions. Comply with classes of terminations indicated.
- 18) Quantity: provide a protective cap at each terminal junction, one on each terminal to which no feeder is indicated to be connected.
- 19) Seal around cables passing through fire rated elements and where cables enter conduits, walkways or equipment.
- 20) Terminations shall be performed by a qualified medium/high voltage electricians. Prior to performing terminations, the qualified electrician shall undergo a suitable training session given by the manufacturer of the termination equipment, or furnish satisfactory documentation or certificate to show that the Contractor has received such training within the last two years.
- 21) One feeder shall be installed in the A manholes and one feeder shall be installed in the B manholes.
- 22) It is the intent of these specifications that the Contractor take extreme care and caution when pulling cable in to conduits. In the utility tunnels only, the Contractor may utilize other methods of handling slack cable, other than on a reel. The method of handling slack cable, while making pulls between pullboxes, shall be submitted to the Owner, prior to cable installation for final approval.
- 23) The cables shall be continuous between terminations. Splicing of 15 kv cable is to be done in each manhole only.
- 24) The cables shall be fanned out and marked for phase identification at each termination.
- 25) The Contractor shall provide equipment to indicate pulling tensions with equipment set to disengage pulling before maximum permissible cable pulling tensions are exceeded. As an option, the Contractor may utilize a "link" between the cable and pulling equipment, set to break at the maximum allowable pulling tension.
- 26) All work on primary conductors shall be done only when such conductors and equipment are de-energized. Unless otherwise noted on the drawings, or directed, any tie-ins or connections to existing primary electric utilities or equipment that necessitate interruptions shall be performed on weekends or holidays. The Contractor shall not interrupt any main electrical utility without a written request for an outage and subsequent approval from the Owner.
- 27) Written request for outages shall be submitted 14 calendar days in advance of the outage date. This request will delineate the particular circuit or service interrupted and the approximate hours the feeder will be off.

- 28) The work to be performed during an interruption of electrical utilities will be preceded by all possible preparation and will be carefully coordinated to minimize the duration of the interruption and work will proceed continuously until the system is restored to normal. The Contractor shall submit, for Owner's approval, a detailed written procedure for each outage, three (3) weeks in advance of the outage date. Unless otherwise indicated, or approved by the Owner, separate outages are required for each building. Refer to the plans for suggested sequence of construction for outages.
- 29) Phasing of the reconnected feeders shall be identical to the existing phasing.
- 30) Cables of the same circuit shall have the phasing identified with red color tape in manholes, switchgear, and boxes. Phase A shall have one wrap, Phase B shall have two wraps, and Phase C shall have three wraps.
- 31) The Owner's Representative shall witness pulling and termination of all 15 kv cables. The Contractor shall provide a written two-week advance notice of the schedule to the Owner.
- 32) Submit actual cable lengths on all pulls and identify lengths on as-built drawings.
- 33) Fault indicators shall be provided in each manhole. Install fault indicators at each manhole, one per phase per manhole. Total of 69 fault indicators. Horstman #H29-3015 or approved equal.
- 34) Provide one 600-amp non-load break splice connection "tee body" in each vault on each new feeder. Make provision for approved racking for the number of feeders represented by the number of conduit entering each vault.
- 35) Cable splicing and terminating products and accessories are:
  - a. Cooper Power Systems, Inc., RTE Components.
  - b. Elastimold
  - c. G&W Electric Co.
  - d. Energy Division, Raychem Corp.
  - e. 3M Electrical Products Division
- 36) Conductor Terminations: Comply with IEEE Standard 48. Insulation class equivalent to that of the cable. Terminations for shielded cables include a shield-grounding strap. Class 1 Termination for Indoor Shielded Cable: Kit with stress-relief tube, nontracking insulator tube, shield ground strap, compression-type connector, and end seal.
- 37) Separable Insulated Connectors: Modular system complying with IEEE386. Disconnecting, single-pole, cable terminators and matching stationary, plug-in, dead-front terminals designed for cable voltage and for sealing against moisture. Manufacturer: Elastimold No. K655L-series. Load-break bushing inserts shall be by Elastimold and completely mate with load-break elbows.
  - a. Load-Break Cable Terminators: Elbow-type units with 200-ampere load make/break and continuous current rating. Coordinate with insulation diameter and conductor size and material of cable being terminated.

Include capacitively coupled test point on terminator body. Load-break bushing inserts shall be by Elastimold and completely mate with load-break elbows.

- b. Dead-Break Cable Terminators: Elbow-type unit with 600 ampere continuous current rating, designed for deenergized disconnecting and connecting. Coordinated with insulation diameter and conductor size and material of cable being terminated. Include capacitively coupled test point on terminator body. Manufacturer: Elastimold No. K655L-series.
- c. Protective Cap: Insulating electrostatic-shielding, water-sealing cap with drain wire.
- d. Grounding Kit: Jumpered elbows, portable feed-through accessory units, protective caps, test rods suitable for concurrently grounding 3 phases of feeders, and carrying case.
- e. Cable shields shall be grounded at all terminations.

- 38) Provide 30-mil, flexible elastomer tape that will expand in fire to form an insulating firewall between fire and cable. Manufacturer: 3M "Scotch Brand 77".
- 39) Provide glass cloth tape with thermosetting silicone adhesive that performs at NEMA Class H temperatures to bind fireproofing tape in place. Manufacturer: 3M "Scotch Brand 69".

C. Conductors (Below 600 volt)

- 1) Wires and cables (600 volts) shall conform to the applicable UL and ICEA Standards for the use intended. Copper conductors with 600 volts insulation unless otherwise specified or noted on the drawings. Stranded conductors for No. 8 or larger where specified.
- 2) Use of aluminum conductors will not be permitted.
- 3) Insulation: Type THHN/THWN insulation, 75 degrees C, for all conductors otherwise specified or noted on the drawings. All control conductors shall be THHN/THWN stranded.
- 4) Use No. 14 minimum for controls unless otherwise specified or noted on the drawings. If the equipment to be installed require larger conductors and conduit sizes than indicated on the drawings, the required changes shall be made without additional charge to the Owner.
- 5) Phase, neutral, and ground conductors shall be color-coded in accordance with NEC. Connect all conductors of the same color to the same phase conductor. Color-coding shall be A-black, B-red, C-blue, N-white, for 120/208 volts and A-brown, B-orange, C-yellow, N-off white for 277/480 volts, with green for all ground conductors. Conductors No. 14, 12 and 10 shall be solid color compounded for entire length.

- 6) For Copper Conductors No. 6 and smaller, connectors shall be "3M Scotch-Lok or T & B Sta-Kon compression or indent type with integral or separate insulating caps.
- 7) For Copper Conductors larger than No. 6: Solderless connectors shall be indent, hex screw or bolt type pressure connectors, properly taped or insulated.
- 8) Plastic tape shall be 8.5 mils minimum thickness, 1,000,000 megohms minimum insulation resistance, oil resistant, vinyl backing, oil resistant acrylic adhesive, incapable of supporting combustion per ASTM D-568 Test Method B.
- 9) All conductor lengths shall be continuous from termination to termination without splices unless approved by the Owner.
- 10) In each empty conduit, except underground conduits, install a No. 14 galvanized steel pull wire or a plastic line having a tensile strength of not less than 200 pounds. In each empty underground conduit install a No. 10 AWG bare, hard drawn copper or copper clad pull wire or a plastic line having a tensile strength of no less than 200 pounds.
- 11) Radius of bends shall be not less than 10 times the outer diameter of the cable.
- 12) Conductors No. 10 and smaller shall be neatly and securely bundled and conductors larger than No. 10 shall be neatly and securely cabled in individual circuits, utilizing marlin twine, two ply lacing or nylon straps.
- 13) Conductors shall not be pulled into conduits until after all plastering or concrete work is completed. All conduits shall be cleaned and swabbed out prior to installation of conductors.
- 14) Install connectors and lugs with manufacturer's recommended tools and with the type and quantity of deformations recommended by manufacturer.
- 15) Where conductors are installed in a parallel arrangement, the phase, neutral, and grounded conductors shall be the same length, have the same conductor material, be of the same size in circular mil area, have the same insulation and shall be terminated in the same manner.

D. Interior Raceway

- 1) Conduits containing medium voltage cable (15kV) in the utility tunnels and buildings, shall be installed in rigid steel conduit, threaded, thick wall, zinc coated on the outside and either zinc coated or coated with an approved corrosion resistant coating on the inside or Intermediate Metal Conduit (IMC): Rigid, threaded, lightweight steel, zinc-coated on the outside and either zinc-coated or coated with an approved corrosion resistant coating on the inside.
- 2) Size conduit as indicated on drawing or as required by Code.
- 3) For conduits containing conductors 600V and below provide the following conduits:

- a. Electrical Metallic Tubing (EMT): Mild steel, zinc coated on the outside and either zinc coated or coated with an approved corrosion resistant coating on the inside. Maximum, size 2-inch electrical trade size unless noted on the drawings or specifically approved.
  - b. Liquid Tight Flexible Conduit: Flexible galvanized steel tubing with extruded liquid tight PVC outer jacket and a continuous copper bonding conductor wound spirally between the convolutions. Where a separate grounding conductor is installed in the conduit, bonding conductor in the convolutions may be omitted.
  - c. Conduit size: Minimum conduit size ½ inch except where specifically approved for equipment connections. Size not noted on drawings shall be as required by the NEC. Conduits for #12 THHN wire shall be sized the same as for #12 TW wire.
- 4) Ground all metallic conduit as required by the NEC.
- 5) For conduits containing medium voltage cable (15 kV) in the utility tunnels and building provide threaded connectors and couplings. Compression type threadless fittings for rigid steel conduit or IMC not permitted. Bushings shall be threaded insulated type, designed to prevent abrasion of wires without impairing the continuity of the conduit grounding system, for rigid steel conduit and IMC. Provide threaded insulated grounding type bushings at all conduit terminations at all boxes (pull, terminal, etc.) and equipment.
- 6) For conduits containing conductors 600V and below provide the following conduit fittings:
- a. Connectors and couplings: EMT couplings and connectors either steel or malleable iron only. "Concrete Tight" or "Rain Tight" and either the gland and ring compression type or the stainless steel multiple point locking type. Connectors to have insulated throats. EMT fittings using setscrews or indentations as a means of attachment are not permitted.
  - b. Bushings: Threaded insulated type, designed to prevent abrasion of wires without impairing the continuity of the conduit grounding system, for rigid steel conduit and IMC larger than ½ inch size and connectors for EMT.
  - c. Liquid Tight Flexible Conduit Fittings: With threaded grounding cone, a steel, nylon or equal plastic compression ring and a gland for tightening. Either steel or malleable iron only with insulated throats and male thread and locknut or male bushing with or without "O" ring seat. Each connector shall provide a low resistance ground connection between the flexible conduit and the outlet box, conduit or other equipment to which it is connected.
- 7) Install rigid steel conduits or IMC conduit for all runs in the utility tunnels. Conduit shall be kept at least 6 inches from paralleled runs of hot water or steam pipes, and at least 2 inches at perpendicular crossings (measured from the piping insulation).

- 8) Install concealed conduits in as direct lines as possible. Install exposed conduits parallel to or at right angles to the lines of the utility tunnels or building.
- 9) Install conduit systems concealed where possible unless otherwise noted. Conduit systems may be exposed in unfinished utility areas, ceiling cavities and where specifically approved by the Owner.
- 10) In any conduit run, the number of quarter bends or equivalent between terminations at cabinets or boxes shall not exceed three (3) 90 degree bends for 4 inch and 5 inch conduits. Conduit runs between cabinets or boxes shall not exceed 300 feet for straight runs or 200 feet for runs with maximum number of bends.
- 11) Protect all vertical runs of conduits or conduits terminating in the bottoms of boxes or cabinets, etc., from the entrance of foreign material prior to installation of conductors.
- 12) Install sleeves for conduit where shown or as required. Conduit sleeves not used shall be plugged with threaded metal recessed type plugs or caps. Sleeve all conduits passing through walls. Sleeves that are used shall be caulked tight with lead yarn.
- 13) Provide supports for horizontal conduits not more than 6 feet apart with not less than two supports for each 10 foot straight length and one support near each elbow or bend including all runs and within 3 feet of all pull boxes, cabinets, fittings, etc. or per the NEC, if more stringent.
- 14) Install individual pipe hangers for all conduits. Spring steel fasteners with hanger rods may be used where noted on the drawings.
- 15) Install multiple (trapeze) pipe hangers where two or more horizontal conduits run parallel and at the same elevation. Secure each conduit to the horizontal hanger member by a U-bolt, or other specially designed and approved fastener.
- 16) Install ½ inch diameter or larger, if required, galvanized steel rods for trapezes, spring steel fasteners, clips or clamps. Wire or perforated strapping shall not be used for the support of any conduit under any circumstance.
- 17) Fasten pipe straps and hanger rods to concrete by means of inserts or expansion bolts to brickwork by means of expansion bolts and to hollow masonry by means of toggle bolts. Wooden plugs and shield shall not be used. Power driven fasteners may be used to attach pipe straps and hanger rods to concrete only where approved by the Owner.
- 18) **Do not** use existing supports in the utility tunnels for new conduit runs.
- 19) Keep raceways at least 6 inches away from parallel runs of flues and steam or hot water pipes. Install raceways level and square and at proper elevations.
- 20) Elevation of Raceway: Where possible, install horizontal raceway above water and steam piping. Due to existing conditions, raceways may be installed below

water and steam in the utility tunnels, where it is not possible to install them above other utilities. Owner to approve the location of all conduits runs.

- 21) Complete installation of electrical raceways before starting installation of conductors within raceways.

#### E. Switchboards and Distribution Panels

- 1) Ratings shall be as shown on the drawings. Manufactured by CUTLER HAMMER, SQUARE D, GENERAL ELECTRIC, SIEMENS, or approved equal. Labeled for service entrance.
- 2) Cabinets shall be dead front sheet metal cabinet with hinged doors for each compartment.
- 3) Circuit breakers shall be molded case type, bolted to the panel bus bars or straps.
- 4) The meter installed shall be an SQ.D PM 870 meter that has communication module for future campus SCADA system. CT'S and cabinet as needed.
- 5) Bus bar shall be copper.
- 6) Each panelboard is to have an engraved plastic nameplate (1") bolted to the front of the cabinet. Nameplate shall identify the panel designation and the source of the feeder to the panel.
- 7) All cable terminations utilizing bolt on connections shall include either switchboard manufacturers' termination kits, or shall be made using Bellville washers.

#### F. Medium Voltage Pad Mounted Switches

- 1) General: The 12.47KV front (and one side) accessible pad mount style gear shall consist of manually-operated, loadbreak, SF6 insulated, 600A line side switches, and electrically-operated 200A load side vacuum fault interrupters with electronic controls. Pad mount style SF6 gear shall be suitable for outdoor operation (NEMA 3R construction).
- 2) Each switch shall have two (2) 3-phase line side switches, and number of load side interrupters as indicated or specified.
- 3) Powell-ESCO SF6 "ArcWhipper" and vacuum fault interrupter circuit breaker switch, or approved equal.
- 4) Each switch shall include the following features as standard equipment.
  - a. Provision for field SF6 gas filling.
  - b. Four (4) removable lifting provisions for balanced lift.
  - c. SF6 gas pressure gauge.

- d. Grounding provisions for (1) 1/2" – 13 ground connection per way plus provisions for one (1) 1/2" – 13 tank ground connection. Ground lugs shall be two-hole NEMA Configuration.
  - e. 1/4" mild steel tank using stainless steel and brass fasteners with no external aluminum parts.
  - f. Non-corrosive three-line diagram and nameplate permanently mounted.
  - g. Padlockable operating mechanism with position indication.
  - h. 10" phase spacing for front/back design and 7" phase spacing for front only design.
  - i. Parking stands for all bushings.
  - j. Pentahead bolt for access doors.
  - k. One (1)-viewing window per switch way for visual indications of line switches and bottle indication for interrupter switches.
  - l. Breakaway operating handle for 600A loadbreak switch.
  - m. Welded or bolted Bushing wells.
- 5) All switch components and entrances shall be assembled in a totally welded 1/4" mild steel tank. Copper wire ropes and copper bus capable of handling momentary and continuous current duty shall internally connect entrances. The switch shall contain no electrically floating metallic parts or components.
- 6) Line Switches: Each SF6 600A Switch (line side) shall be equipped with an internally mounted operating mechanism capable of providing quick-make, quick-break operation in either switching direction. The mechanism must be capable of delivering sufficient torque and shall be provided with latches for each position to assure load interrupting, fault closing and momentary ratings. The mechanism shall use compression type springs to assure long life and reliability. All switch positions are to be clearly identified and padlockable. The operating mechanism shall be actuated from outside the switch tank by a removable, breakaway action-operating handle. The operating shaft shall be made of stainless steel for maximum corrosion resistance. A double "O" ring type operating shaft seal shall be used for a leak resistant, long life seal.
- 7) Electrical Ratings and Standards – 600A SF6 Switch (line side): Switches shall be designed, tested and built per ANSI C37.72-1987 standards. The switch assembly itself shall be rated:
- |   |      |
|---|------|
| Maximum design voltage, kV .....          | 15.5 |
| Impulse level (BIL), kV.....              | 110  |
| Continuous & loadbreak current, Amps..... | 600  |
| One minute withstand, AC kV .....         | 34   |
| 15 minute withstand, DC kV.....           | 53   |
| Momentary current, kA, ASYM.....          | 40   |
| Fault-close current, kA, ASYM.....        | 40   |
| One second current, kA, Sym.....          | 25   |
| Maximum capability, amps .....            | 3000 |
| Operations at 600 amps .....              | 1200 |
- 8) Cable Entrances – 600A SF6 switch (line side) cable entrances shall be tested to ANSI/IEEE 386 and shall be rated 600A with Quick-Change disconnectable apparatus bushings. Line side cable terminations shall be performed utilizing deadbreak 600A T-body connectors. Vacuum interrupter (load side) bushing wells shall be tested to ANSI/IEEE 386 and shall be rated 200A. Contractor



shall field install 200A bushing inserts. Load side cable terminations shall be performed utilizing 200A loadbreak elbows.

- 9) Electrical Ratings and Standards – 200A or 600A Vacuum Interrupter (load side): The vacuum interrupter shall be a non-reclosing, manual reset device incorporating vacuum bottles. It shall be designed, tested and built per application sections of ANSI C37.60-1981 and C37.72-1987. The vacuum interrupter assembly itself shall be rated:

Maximum design voltage, kV .....	15.5
Impulse level (BIL), kV.....	110
Continuous and loadbreak current, Amps.....	600
One minute withstand, AC kV .....	34
Symmetrical interrupting rating, kA .....	12
Asym. Interrupting rating, kA .....	19.2

- 10) ANSI C37.60 Fault interrupting Duty

Percent of Maximum Interrupting rating interruptions	Current	Approx. No. of Faults
15-20%	2,000A	44
45-55%	6,000A	56
90-100%	12,000A	16

- 11) Vacuum Interrupter Construction/Operation: The Vacuum interrupter shall be an assembly consisting of a vacuum bottle and the operating mechanism.
  - a. The vacuum interrupter operating mechanism shall consist of the support assembly, linkage, spring latch mechanism, and solenoid utilized for electronic tripping. Maximum interrupting time shall be three cycles. (50 msec).
  - b. The vacuum bottle of the vacuum interrupter shall have a movable contact shaft to indicate the contact position, open or closed. This contact position indicator shall be fully visible through viewing windows supplied in the switch tank.
  - c. Each 200A/600A-phase tap is to be equipped with an individual 600A vacuum interrupter fully enclosed in an SF6 insulated switch tank. Electrical opening shall be field selectable single or three phase. Closing (reset) of the vacuum interrupter shall be electrically operated.
  - d. The mechanical linkage assembly shall provide for a “trip free” operation that allows the vacuum interrupter to interrupt independent of the operating lever.

- 12) Electronic Control

- a. An electronic assembly shall be provided to sense load and fault current on each phase of the load tap circuits. The electronic control shall be powered

from the Potential transformers mounted inside the SF6 insulated switch tank. The electronic control shall monitor the load or fault current on the individual phases of the load tap circuits using input from the internal current transformers.

- b. Electronic trip capability shall be field selectable, single or three phase. Temperature range shall be -73°C to 80°C.
  - c. Manual electronic tripping shall be provided with a trip button located inside the electronic enclosure. Minimum trip selection shall be accomplished with selector knobs inside the electronic enclosure.
  - d. The Customer shall specify trip time. Electronic assemblies shall be field retrofittable. Electronic controls shall be able to emulate most common protection curves, including “E” and “K” speed power fuses, fuse links and overcurrent relays. Trip selection shall be in ten (10) field selectable levels. Overcurrent relays shall be Basler Electric BE1-50/51 or equal.
  - e. Maximum time for power up and ready-to-trip when closing on a circuit shall be 10% of the trip time or ½ cycle, whichever is greater.
  - f. Time current curves shall be suitable to protect associated transformer and primary and secondary conductors. Submit curves for approval.
- 13) Cable Entrances – 200A Vacuum Interrupter (load side): Cable entrances shall be tested to ANSI/IEEE 386.
- 14) Enclosure
- a. Switch shall be housed inside a 12-gauge mild steel tamper resistant steel enclosure with access cover, hinged doors with recessed handles, pentahead bolt, and provisions for padlocking. The switch enclosure shall be independent of the switch and easily removable for replacement. Switch and enclosure shall be furnished with lifting provisions and finished with custom beige paint color and meets ANSI C37.72 and C37.72 and C57.12.28 standards.
  - b. The enclosure for pad mount style SF6 gear shall be of weatherproof construction for outdoor use and shall be front accessible only (plus one side access to electronic controls).
- 15) Factory Production Tests
- a. The bulk SF6 gas supply and each individual switch shall be tested for moisture content. Each individual switch shall undergo a mechanical operation check and a leak test. The switch shall be factory filled with SF6 and AC hi-pot tested one-minute phase-to phase, phase-to-ground and across the open contacts. Circuit resistance shall be checked on all ways.
  - b. Switches will be shipped factory filled with SF6 gas. Tank shall be designed to withstand 15-psig internal pressure and an external pressure of 14 psig without affecting the performance of the switch.

- 16) Install the switch in accordance with approved shop drawings, manufacturer's recommendations and as specified. Concrete pads shall be sized as recommended by manufacturer and shall be as shown on the drawings. Provide grounding/bonding connections for neutrals and transformer cases as specified, as indicated on the drawings, as recommended by the manufacturer or as required by code.
- 17) Securely fasten equipment to the concrete pad with drop-in type, expanding anchors and bolts (minimum diameter, 1/2"), per equipment manufacturer's recommendations. Pad mounted gear shall be anchored to concrete pads utilizing 5/8" diameter anchor bolts, and anchor bracket furnished with pad mounted gear. Anchors shall be provided and installed at each of four- (4) corner of gear in location per the manufacturer recommendations.

G. Transformers

- 1) Transformer characteristics, electrical and physical, as well as definitions, terminology and voltage designations, except as stated in these specifications, shall be in accordance with ANSI C57.12 series and NEMA TR-1 latest revisions, except as modified herein. Transformers shall be manufactured by ABB or approved equal.
- 2) Transformer shall conform to the dimensions of the latest edition of ANSI C57.12.26 except for the primary cable compartment which shall have a minimum depth of 20" to facilitate ease and safety of removing the load break primary connectors.
- 3) The external surfaces shall be constructed of steel, 13 gauge minimum or approved equal.
- 4) The finish shall be of weather-resistant, custom color, which shall have a minimum thickness of 3.5 mils on all external surfaces. The Owner will designate the exact color and that will be desert tan.
- 5) The paint finish shall be capable of passing a 1500 hours salt spray test per ASTM B117 and Federal Specification TT-P-141 with no blistering and passing method 6061 with less than 1/16" underfilm corrosion.
- 6) An extra coating specifically designed to minimize corrosion shall be applied to any surfaces that will contact the pad and will extend minimum of one inch up the side of any such surface.
- 7) The bottom edge of the enclosure shall provide for flush mounting on a flat, rigid mounting surface to prevent entry of foreign objects into the compartment.
- 8) All windings shall be copper (no exceptions)
- 9) All material used in the construction shall be new and original to the transformer. Rebuilt or reconditioned units in any form or manner are not acceptable.

- 10) The pad mount transformer shall be mineral oil filled and shall be in accordance with the latest edition of the NEC.
- 11) Suitable means for use of a standard pad lock on the compartment door shall be designed and provided so as to resist prying or breaking off by screwdrivers, wrecking bars, tire irons, single-socket lug wrenches or other readily accessible tools. There shall be no exposed screws; bolts or other fastening of hinging devices which are externally removable (with the exception of the recessed pentahead bolt) that would provide access to energized parts of enclosure. In addition to the regular locking provision, the compartment door shall be secured by a recessed, captive pentahead bolt that threads into a nut with a blind hole. A pentahead bolt shall be considered "captive" when the retention scheme will prevent it from being readily removed during normal operation of the door. The recess is to be nonrotating. The dimensions of the pentahead bolt and nonrotating recess shall comply with figure 11 of ANSI C57.12.26, latest revision. All doors may be secured with a single bolt, one bolt will be sufficient.
- 12) These transformers shall comply with the structural strength and integrity portion of ANSI C57.12.28 latest revision.
- 13) Transformers shall, as a minimum, have the following specification and accessories:
  - a. 3-phase, 60 hertz, 55° centigrade AWR, 40° average ambient
  - b. Primary: 12470
  - c. HVI position is delta
  - d. HV KV bil is 095
  - e. HVI taps is (+2, -2 @ 2.5%)
  - f. Secondary is 208Y/120 or 480Y/277
  - g. Accessories:
    - i. 200 AMP HV Bushing wells
    - ii. 3 loadbreak inserts, 3 feed-thru inserts
    - iii. ANSI C57.12.26 Fig 2 & 3 HV bushing pattern (minimum)
    - iv. LV bushings with 4 hole NEMA spade terminals
    - v. ANSI minimum staggered low voltage pattern
    - vi. Dial type thermometer
    - vii. Liquid level gauge
    - viii. Pressure/vacuum gauge
    - ix. 15 KV elbow arrester – 15 KV interface
    - x. Drain valve and sampler
    - xi. 24" deep cabinet
    - xii. Penta-head cabinet handle bolt
    - xiii. Mineral Oil
    - xiv. Copper windings
    - xv. Shipped with a positive nitrogen blanket
  - h. 5.0% impedance +/- or as indicated
- 14) Transformers shall be of the pad mounted design, radial feed type, delty-wye connection and shall have two (2) 2-1/2% taps above and two (2) 2-1/2% taps below normal. Taps shall be suitable for de-energized operation only. The tap changer switch shall be ganged and shall be externally operable. The operating handle shall be located in the high voltage compartment above the

high voltage bushings. The tap changer shall be set on the 100% tap at the factory and shall be secured to prevent inadvertent change from this position.

- 15) A two-hole NEMA grounding lug shall be provided on the transformer high voltage and low voltage compartment.
- 16) Transformer shall be of triplex or five-legged core design and connected delta-wye, with secondary neutrals brought out to a neutral bushing in the secondary department. Each neutral shall be bonded to the transformer tank with copper straps.
- 17) Transformer shall carry its continuous rating with average winding or temperature rise by resistance that shall no exceed 65° centigrade rise, based on an average ambient of 30° centigrade over 24 hours with a maximum of 40° centigrade.
- 18) Primary connections shall be rated for dual voltage identified above. Terminals shall be three bolted type-bushing wells for radial feed. Transformer design shall allow field replacement of the high voltage bushing wells and low voltage bushings by means of common hand tools and oil handling equipment, without totally untanking the transformer. Unit shall be shipped complete and ready for field installation of primary elbows – **NO EXCEPTIONS**.
- 19) The LIVE FRONT secondary connections shall be insulated from the transformer case by 9KV porcelain bushings and shall be 4-hole spade type. Unit shall be shipped with all bushings and spaces installed and ready for cable terminations -- **NO EXCEPTIONS**.
- 20) The terminal marked "Xo" shall be the neutral terminal and shall be supplied with a removable copper ground strap bussed to the transformer tank. This ground strap shall be capable of carrying a line to ground fault of the magnitude and duration as defined in ANSI C57.12.00 latest edition.
- 21) An easily readable, corrosion resistant, nameplate conforming to ANSI C57.12.00 latest revision shall be furnished with each transformer. It shall be mounted on a stationary surface in the secondary compartment, and shall be located such that it is easily readable with all cables installed and in place.
- 22) The nameplate shall be stamped "NON PCB" to reflect the fact that the transformer oil contains less than 1-PPM PCB at the time of manufacture. Failure to meet this requirement is grounds for automatic rejection of transformer.
- 23) The manufacturer shall perform all design tests as well as tests exhibiting the mechanical and thermal short circuit capabilities of the transformers as defined in ANSI C57.12.00 and C57.12.90 latest revisions. Certified test results from all of the above tests shall be submitted to the Engineer for evaluation with approved drawings.
- 24) The manufacturer shall also perform all of routine tests as defined in ANSI C57.12.00 latest revision on each transformer, with each shipment.

- 25) The manufacturer shall also submit to the Owner, no-load loss watts and load loss watts derived in accordance with ANSI C57.12.00 latest revisions. These reports shall contain NLL, winding losses impedance.
- 26) Temperature rise shall not exceed the ANSI standard 65 degree rise for all transformers, except the HSSB Chiller transformer which shall not exceed 55 degree rise. If it is determined through watts loss at full load and tank dimensions and oil volume that the manufacturer exceeds the ANSI standard for any transformer, then the units will be returned for correction of full credit by the manufacturer. Freight, rental, connection and other charges will be the responsibility of the manufacturer should this become necessary.
- 27) Standard Tests: The following tests shall be made on the transformer. The numbers shown do not necessarily indicate the sequence in which the tests shall be made. All tests shall be made in accordance with the latest revision of ANSI Standard Test Code C57.12.90, where applicable.
  - a. Turns-ratio tests on the rated voltage connection and on all tap connections.
  - b. Polarity and phase-relation tests on the rated voltage connection.
  - c. No-load loss and excitation current at rated voltage on the rated voltage connection.
  - d. Impedance and load loss at rated current on the rated voltage connection of each unit and on the tap extremes on one unit only of given rating on this project.
  - e. Applied potential test 60 Hz on high and low voltage.
  - f. Induced potential tests – 400 Hz.
  - g. Mechanical leak and pressure test on tank and coolers.
- 28) In addition to the above standard tests, the transformer shall be given a Production Line Impulse Test.
- 29) Copies of Certified Design Tests, for the Engineer shall furnish audible sound level and temperature rise upon request.
- 30) All external doors shall be provided with “CAUTION – HIGH VOLTAGE – KEEP OUT” signs.
- 31) The inside of each door shall be provided with a “DANGER – HIGH VOLTAGE – KEEP OUT – QUALIFIED PERSONNEL ONLY” signs.
- 32) Provide Owners an ID number – micarta label, bolted to the front of door as designated by Owner.
- 33) Failure to comply with any portion of this specification is just cause for rejection of shipment. The bidder shall incur and bear all cost associated with the removal of the rejected items of the Owner’s property. The Owner shall be held free from harm for any liabilities incurred by the Contractor during shipment and transportation to the site, and if required, back to the manufacturer.
- 34) All secondary cable terminations utilizing bolt on connections shall include either transformer manufacturers’ termination kits, or shall be made using Bellville washers.

## H. Identification

- 1) UNM shall provide label terminology (wording). Signs and labels shall generally match existing.
- 2) Manhole covers shall match existing. Circuit numbers shall be added to existing "label tags" on the cover. Manholes shall be numbered as directed by UNM.
- 3) Labels for equipment shall be engraved melamine plastic laminate, 1/16-inch minimum thick for signs up to 20 square inches, or 8 inches in length; 1/8-inch thick for larger sizes. Engraved legend in white letters on red face and punched for mechanical fasteners. Provide for boxes, terminal cabinets, SF6 switches, transformers, interior of manholes, etc.
- 4) Fasteners for Plastic-Laminated nameplates: Self-tapping stainless steel screws or number 10/32 stainless steel machine screws with nuts and flat and lock washers.
- 5) Adhesive Marking Labels for Raceway shall be pre-printed, flexible, self-adhesive labels with legend indicating voltage and service.
  - a. Raceways 1-inch and smaller: 1-1/8 inches high by 4 inches long.
  - b. Raceways larger than 1-inch: 1-1/8 inches high by 8 inches long. Color shall be black legend on red background. Self-adhesive vinyl tape not less than 3 mils thick by 1 inch to 2 inches in width.
- 6) Labels for cables in distribution manholes shall be...
- 7) Coordinate names, abbreviations, colors, and other designations used in electrical identification work with existing designations. Install numbers, lettering, and colors as approved in submittals and as required by code.
- 8) Install identification devices in accordance with manufacturer's written instructions and requirements of NEC.
- 9) Where identification is to be applied to surfaces that require finish, install identification after completion of finish work.
- 10) Identify Pull Boxes and Terminal Cabinets: Code-required caution sign for boxes shall indicate system voltage in white preprinted on red background. Install on outside of box pop-riveted to cover. Also label box covers with identity of contained circuits. Use pressure-sensitive plastic labels at exposed locations and similar labels or plasticized card stock tags at concealed boxes.
- 11) Use conductors with factory-applied color the entire length of the conductors or the following field-applied color-coding methods may be used in lieu of factory-coded wire for sizes larger than No. 10 AWG.
  - a. Apply colored, pressure-sensitive plastic tape in half-lapped turns for a distance of 6 inches from terminal points and in boxes where splices or taps

are made. Apply the last two laps of tape with no tension to prevent possible unwinding. Use 1-inch-wide tape in colors as specified. Do not obliterate cable identification markings by taping. Tape locations may be adjusted slightly to prevent such obliteration.

- b. In lieu of pressure-sensitive tape, colored cable ties may be used for color identification. Apply three ties of specified color to each wire at each terminal or splice point starting 3 inches from the terminal and spaced 3 inches apart. Apply with a special tool or pliers, tighten for snug fit, and cut off excess length.
- 12) Power Circuit Identification: Securely fasten identifying tags marker bands to cables, feeders, and power circuits in pull boxes, junction boxes, and switchboard rooms with ¼ inch steel letter and number stamps with legend to correspond with designations of Drawings. If metal tags are provided, attach them with approximately 55-lb test monofilament line or one-piece self-locking nylon cable ties.
  - 13) Conductors indicated to be for future connection or connection under another contract with identification indicating source and circuit numbers.
  - 14) Where multiple branch circuits are present in the same box or enclosure, label each conductor or cable. Provide legend indicating source, voltage, circuit number, and phase for branch circuit wiring. Phase and voltage of branch circuit wiring may be indicated by mean of coded color of conductor insulation. Use consistent letter/number conductor designations throughout on wire/cable marking tapes.
  - 15) Match identification markings with designations used in panelboards shop drawings, contract documents, and similar previously established identification schemes for the facility's electrical installations.
  - 16) Apply equipment identification labels of engraved plastic-laminate on each major unit of electrical equipment in building, including central or master unit of each electrical system. Except as otherwise indicated, provide single line of text, with ½-inch high lettering in black field. Text shall match terminology and numbering of the contract documents and shop drawings. Apply labels for each unit of the following categories of electrical equipment.
    - a. Pull boxes, terminal cabinets and enclosures
    - b. Access doors and panels for concealed electrical items
    - c. Electrical switchgear and switchboards
  - 17) Install labels at locations indicated and at locations for best convenience of viewing without interference with operation and maintenance of equipment.
  - 18) Install "12470 VOLTS" labels on all 15 kv feeder and/or conduits in the utility tunnels, manholes and buildings at approximately 50' on centers. Install feeder number labels on all 15 KV feeder conduits in the utility tunnels and buildings at approximately 30' on centers.

## I. Field Testing



- 1) All equipment and medium voltage cable shall be tested for proper installation and operation. Equipment shall satisfactorily operate on the existing UNM system.
- 2) Tests shall conform to International Electrical Testing Association (INETA) Standard ATS, "Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems," and the following:
- 3) Contractor shall arrange and pay for the services of an independent electrical testing organization to perform tests on transformers, and SF6 pad mounted gear.
- 4) Test Objectives: To assure equipment installation is operational within industry and manufacturer's tolerances, is installed in accordance with contract documents, and is suitable for energizing.
- 5) Procedures: Upon satisfactory completion of tests, attach a label to tested components.
- 6) Schedule tests and notifies the Owner at least two (2) weeks in advance of schedule for test commencement.
- 7) The testing organization shall make a written report of observations and tests. Report defective materials and workmanship and retest corrected defective items.
- 8) Testing organization shall submit written test reports to the Owner.
- 9) Testing for transformers shall include insulation resistance test, taps verification and excitation test.
- 10) Correct deficiencies identified by tests and make ready for retest. Verify that equipment meets the specified requirements.
- 11) Upon completion of installation, inspect interiors and exteriors of accessible components. Remove paints splatters and other spots, dirt, and construction debris. Touch up scratches and mars of finish to match original finish.
- 12) Adjust transformer taps to provide optimum voltage conditions at utilization equipment.
- 13) Arrange and pay for the services of factory-authorized service representatives to adjust and demonstrate equipment operation, including transformers, pad mounted gear for Owner's maintenance personnel.
- 14) After the contractor has completed the installation of the 15 KV cables, they shall be tested to assure that all the material continues to possess the original characteristics as required by the governing codes and standards listed in these specifications and as recommended by the cable manufacturer. The Contractor shall provide a written seven- (7) day notice to the Owner prior to testing 15 KV cable. A representative from the Owner will be onsite during testing of each segment of the cable. **The 15 KV cable tests shall be performed from**

**termination to termination. Coordinate with Section 16015 – Electrical Commissioning.**

- 15) The test objectives are to assure cable installation is operating within industry and manufacturer's tolerances, is installed in accordance with Contract Documents, and is suitable for energizing.
- 16) The procedures shall comply with the INETA standard and IEEE 400. Upon satisfactory completion of tests, attach a label to tested components.
- 17) The Contractor shall furnish all instruments, equipment and personnel required for the tests, which shall be conducted in the presence of the Owner or his authorized representative. These acceptance tests shall be in accordance with ICEA-NEMA Standards after the cable is installed, but before line voltage is applied. The Owner will determine whether the cable will be tested before or after its termination on equipment.
- 18) High voltage testing as described herein shall be performed on the new cable installed by the Contractor.
- 19) A voltage test shall be performed on all primary cables installed or reconnected under the contract in accordance with ICEA Pub. No. S-19-81 (third edition) recommendations for ozone resisting types of insulation. In the event the cables fail to meet this test, the entire run shall be removed and a new cable installed at no additional cost to the Owner. A means shall be included in the measurement for determining the waveform of the alternating current voltage. A sphere spark gap may be used to measure the test voltage. An approved means of measuring the test voltage directly shall be used. The DC voltage shall be applied such that the rate of increase to the specified steps and voltage level is uniform and each step is completed from one to sixteen seconds. Since the cable may be connected to other apparatus during tests, care shall be taken to avoid exceeding the breakdown voltage of any connected apparatus. Any damage to electrical equipment or apparatus shall be repaired by the Contractor at no additional expense to the Owner.
- 20) A report of the tests shall be prepared and submitted immediately to the Owner for review and approval. Reports shall be sent by facsimile (FAX). All tests and reports shall follow the cable manufacturer recommendations. Upon acceptance of the report, submit to the Owner in quintuplicate. The report shall list the test equipment used; voltage time applied for each cable and shall bear the signature of the Contractor and the person in charge of the tests.
- 21) The Contractor shall provide the source of power as required for the test equipment.
- 22) In the event of lack of proper insulation, or in the event that any cable fails to meet any of the above tests, the entire faulty cable shall be removed and new cable shall be installed and tested at no additional cost to the Owner.

END OF SECTION