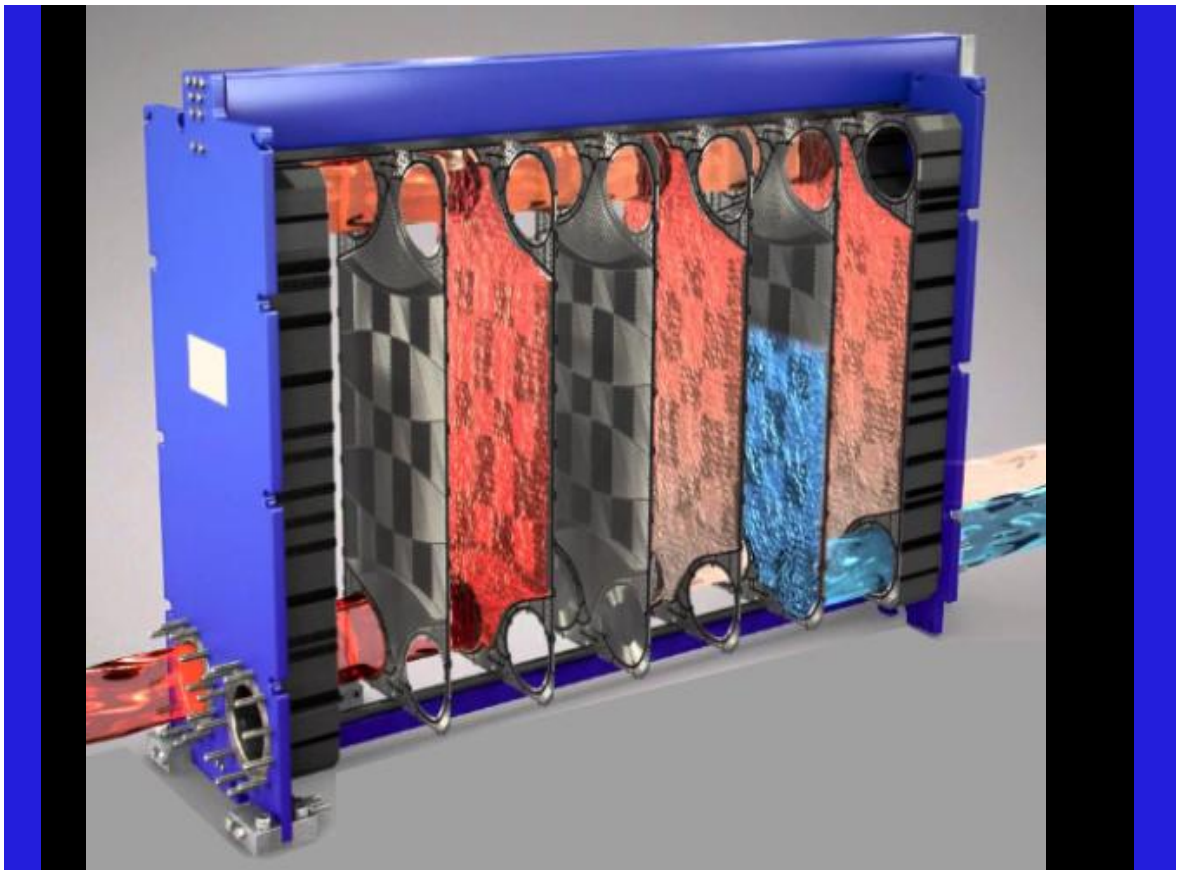
SAWS District Cooling System - Customer Connection Standards

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San Antonio Water System
District Cooling System

DCS Professional Engineering Services – Phase II
October 23, 2026



SAWS District Cooling System - Customer Connection Standards

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1. Introduction

The San Antonio Water System (SAWS) is a public utility owned by the City of San Antonio (COSA). SAWS provides service to most of the population within the corporate limits of the City and Bexar County. SAWS' mission is to provide "Sustainable, Affordable Water Services" to all its customers in the San Antonio area.

While primarily known as a municipal water/wastewater utility, SAWS and its predecessor agencies have owned and operated district energy infrastructure in downtown San Antonio since 1968. Today, SAWS owns and operates four chilled water assets (consisting of buildings, equipment, distribution systems, easements, and Rights-of-Way) serving the Downtown district and Port San Antonio, at the locations below:

- Commerce Street Plant, 900 E. Commerce Street
- Cherry Street Plant, 725 Cherry Street
- Port San Antonio, Building 356, 335 Airlift Drive
- Port San Antonio, Building 1625, 307 Chitty Drive

With district cooling, chilled water is generated by a centralized plant and distributed through an underground piping loop to individual building customers. In lieu of their own cooling equipment plants, customers utilizing district cooling simply have an energy transfer system to reject their building heat onto the loop. The SAWS District Cooling System (DCS) provides the following benefits:

- Superior energy efficiency, sustainability, and overall lower cost of service versus self-generation,
- Improved system resiliency and reliability,
- Reduced maintenance, operations, and equipment replacement costs,
- Avoidance of large up-front capital cost for cooling equipment,
- Reduction of space needed for building cooling equipment, which can be repurposed for other revenue-generating activities.

1.1 Purpose

The purpose of this manual is to provide the procedures and standards for new Customer connections onto the SAWS District Cooling System (DCS). This includes the underground distribution piping from the SAWS chilled water mains in the Right-of-Way (ROW) into the Customer building; the energy transfer station (ETS) within the Customer building, including the heat exchanger, piping, valves, and other appurtenances; and the metering cabinet, which includes the flow meter, temperature and pressure sensors, and other accessories needed to meter the chilled water usage for Customer billing and provide diagnostics for SAWS operations. The entirety of the ETS and building chilled water system, as demarcated by the Point of Delivery and Point of Return, will be the responsibility of the Customer. SAWS is responsible for the ROW piping and metering cabinet.

New and prospective Customers and their professional service providers and installing Contractors shall abide by the standards in this manual when planning, designing, and constructing their ETS connection to the SAWS DCS. Any deviations from the standards will require SAWS written approval.

This manual is applicable to new Customer connections only and does not infer any requirements on existing Customers.

2. Definitions and Acronyms

2.1 Definitions

Capital Cost Recovery Fee: Fixed Monthly Fee imposed by SAWS on the Customer bill to recover the unique costs of extending SAWS chilled water to the Customer. It includes the necessary distribution piping in the Right-of-Way, and the onsite metering for billing. These costs are typically recovered over a 20-year period.

Customer: The end user of an account billed for chilled water service.

Contract Demand: The contracted billing amount for chilled water in tons of cooling, as identified in the Customer's service agreement.

District Cooling System (DCS): Thermal energy system that distributes chilled water from a central source to multiple customers for use in space cooling and dehumidification. The DCS consists of central chiller plants, piping distribution network, and customer energy transfer stations.

Delta T (ΔT): The temperature differential between the Customer's chilled water supply and return temperature, as measured on the SAWS side of the heat exchanger. For example, a supply temperature of 42°F and return temperature of 57°F results in a Delta T of 15°F. Each Customer will have a varying Delta T based on their system efficiency. Lower Delta Ts require more water flow to deliver the same cooling tonnage, resulting in the need for larger piping, larger pumps, and overall higher DCS energy consumption.

Energy Transfer Station: The heat exchange interface between the district cooling system and the Customer, located within the Customer's building, used for delivery of chilled water service. Includes chilled water piping in the Right-of-Way and Customer's building mechanical room, heat exchanger(s), metering station, and related valves, control instruments, and appurtenances.

Engineer of Record: The person who is legally responsible for the technical design of the project and registered by the state as a Professional Engineer (P.E.) to be qualified to make design and construction decisions within their area of competence.

Heat Exchanger: Heat transfer device that hydraulically decouples the SAWS district chilled water system from the Customer's building chilled water system.

Heat Exchanger Approach: The temperature difference between the SAWS CHWS and the Customer's building CHWS. For example, a SAWS supply temperature of 42°F and building supply of 44°F results in an approach temperature of 2°F. Approach is a measure of heat transfer efficiency and is proportional to the amount of heat transfer.

Mechanical Room: Interior room inside the Customer's building that houses the energy transfer station. Alternatively referred to as Heat Exchanger room.

Operation Date: The date of commencement of chilled water service and start of the contract term.

Right-of-Way: The legal right to pass through a specific route through property belonging to another. Typically refers to the piping in the street up to the Customer's property line.

Service Point: The point at which chilled water is delivered to the Customer (Point of Delivery) and the point at which Customer returns chilled water (Point of Return) to SAWS. The POD and POR are at the underground lateral piping flange breaks at the property line.

Ton of Refrigeration (Ton or T): A unit of power used to describe the heat-extraction capacity of refrigeration equipment. The rate of heat transfer that results in the melting/freezing of 1 ton of ice at 32°F in 24 hours.

Ton-hour (Ton-hr.): A unit of energy to describe the amount of energy transferred in one hour at the rate described in a cooling ton. Quantity of thermal energy in tons (12,000 BTU) absorbed or rejected in one hour.

2.2 Acronyms

Table 1: Acronyms & Abbreviations

Acronyms	Description
AFF	Above Finished Floor
ASHRAE	American Society of Heating, Refrigeration, and Air-Conditioning Engineers
BMS	Building Management System
BTU	British Thermal Unit
CCS	Customer Connection Standards
CHW	Chilled Water
CHWP	Chiller Water Pump
CHWS	Chilled Water Supply
CHWR	Chilled Water Return
COSA	City of San Antonio
CUP	Central Utility Plant
DCS	District Cooling System
DP	Differential Pressure
EOR	Engineer of Record
ETS	Energy Transfer Station
°F	Degrees Fahrenheit
FCV	Flow Control Valve
GC	General Contractor
GPM	Gallons per Minute
HMI	Human Machine Interface
HX	Heat Exchanger
I/O	Input/Output
LOI	Letter Of Intent
NTP	Notice to Proceed
PLC	Programmable Logic Controller
POD	Point of Delivery
POR	Point of Return
R&R	Repair & Replacement
RFI	Request For Information
RH	Relative Humidity
ROW	Right-of-Way
SAWS	San Antonio Water System
SCADA	Supervisory Control and Data Acquisition
T&C	Terms & Conditions
TES	Thermal Energy Storage
VFD	Variable Frequency Drive

3. DCS Customer Initiation

Potential customers may refer to Section 9 - Typical Timeline of Activities to learn more about time required for Customer Initiation, as well as Design and Construction.

3.1 Life Cycle Cost Analysis (LCCA)

SAWS will conduct an initial screening of potential customers, utilizing the Customer's projected chilled water load and consumption along with a high-level estimate of connection costs to determine the financial viability for the Customer.

If requested by the Customer, SAWS will provide an analysis showing the estimated life cycle cost savings for connecting to the SAWS DCS versus the Customer self-generating chilled water. This analysis is based on simplifying assumptions known at the time of the analysis such as building area, space usage, load factors, and pertinent utility rates. The LCCA results are not a guarantee of future performance but demonstrate the likely order of magnitude savings the Customer can expect from connecting to the SAWS DCS system.

3.2 Letter of Intent (Optional)

SAWS utilizes various methods and networking channels to market the downtown district cooling system. Once a potential Customer has been identified, the first step is for the Customer to express interest in utilizing chilled water from the SAWS DCS. This can be formalized through a letter of intent (refer to Appendix A.1.1 for sample). The letter of intent will identify the Customer, building type, estimated cooling load, and expected Operation Date for chilled water. The letter of intent is not a binding document, but it gives SAWS consent to initiate onboarding efforts with the Customer.

3.3 Sample Utility Bill

As a complement to the LCCA, SAWS will also provide the Customer with a sample monthly utility bill. The utility bill is broken down into the following components:

- Demand (Capacity) Charge: A fixed rate charge that is allocated to the Customer on a dollar per contracted ton basis ($/ton).
- Commodity Charge: A variable rate charge representing SAWS' direct energy and water costs that is proportionally allocated to each Customer based on their ton-hour consumption for that month ($/ton-hr.).
- Capital Cost Recovery Fee: A fixed monthly fee to recover the unique costs of adding the Customer to the DCS. It includes the necessary distribution piping in the Right-of-Way, and the metering for billing. These costs are typically paid upfront (financed) by SAWS and recovered from the Customer over a 20-year period.
- Delta T Adjustment Charge: The Delta T adjustment is added to the Commodity Charge and represents the added or avoided energy costs. It provides a penalty to a Customer with low/poor Delta T or an incentive to those with high/superior Delta T. The Delta T adjustment to the Commodity Charge shall be calculated as the Commodity Charge multiplied by 6 percent for each degree (rounded to the nearest degree), in Fahrenheit, when the Delta T is outside the range of 12 to 15 degrees. The Delta T adjustment will apply only for the months of April, May, June, July, August and September.

Current DCS rates are published and approved by COSA. Refer to City Ordinance 2022-11-10-0869 in Appendix A.1.2 for chilled water rates.

3.4 Customer Service Agreements

Lastly, if the Customer chooses to proceed with utilizing chilled water from the DCS, SAWS will provide a Service Agreement for the Customer to sign (refer to Appendix A.1.3 for sample). The service agreement identifies the terms of the agreement, including contract cooling tons, service point, start date of chilled water service, and the responsibilities and terms for each party, summarized below and elaborated in Section 10 - Responsibility Matrix.

- The Customer shall provide the design for the energy transfer station and site piping in compliance with the SAWS Customer Connection Standards Manual and all applicable codes and standards.
- The Customer will install, operate, and maintain the SAWS-side (cold-side of the heat exchanger) chilled water system to the POD/POR at the property line. The ETS Heat Exchanger hydraulically decouples SAWS' and the Customer's building chilled water systems.
- The Customer will install, operate, and maintain the Building-side (hot-side of the heat exchanger) chilled water system and associated terminal units and controls.
- SAWS will design, install, operate, and maintain the ROW piping and ETS metering cabinet.

Once the Customer agreement is signed, SAWS and the Customer will initiate their respective duties and design efforts as outlined in the following chapters.

4. Right-of-Way Piping

For new Customer chilled water service connections, SAWS will extend laterals from the nearest chilled water mains in the ROW to the Customer's property line. SAWS' existing underground chilled water distribution system is shown in the Figure below.

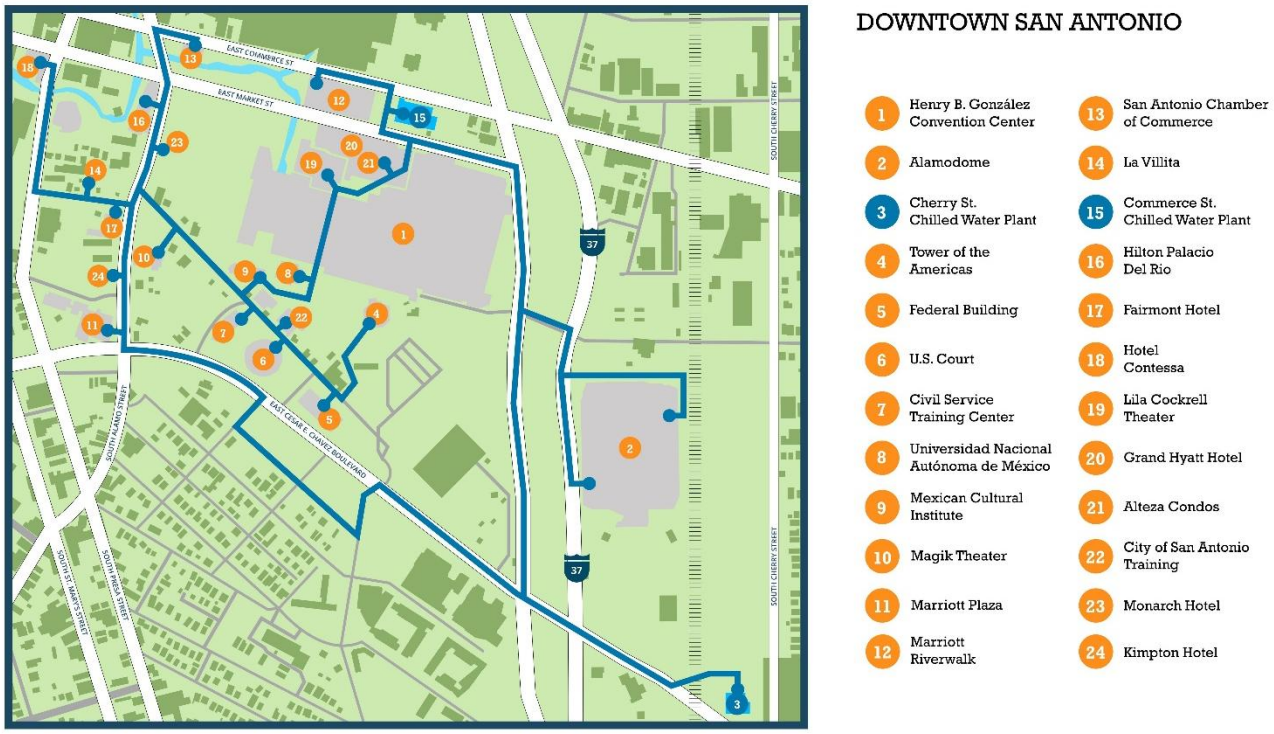


Figure 1 – Downtown CHW Map (as of October 2026)

SAWS' engineering consultants will develop the plan and profile design drawings for the lateral piping in the ROW. This will include the piping connection to the chilled water mains in the ROW and routing the laterals to the Customer's property line. The Customer is responsible for providing a conflict-free route (plan, elevation, and any required offsets) for the chilled water laterals to traverse the site from the property line to the ETS room. The Customer shall provide the project site's Geotechnical report and disclose any known or suspected environmental risks.

SAWS' piping Contractor will permit and install the piping from the ROW to the property line, while the Customer's piping Contractor will permit and install the piping from the property line to the Customer building mechanical room.

5. Energy Transfer Station Requirements

The Customer's Engineer of Record (EOR) will design the Energy Transfer Station in accordance with SAWS standards. Refer to the Appendix A.2 for the ETS schematic and typical details. General ETS requirements are outlined below.

5.1 Room Requirements

The Customer shall provide a dedicated mechanical room to house the energy transfer station. The mechanical room shall be located on an exterior wall adjacent to the chilled water easement, at ground or basement level. The mechanical room shall be sized to provide ample walking paths, equipment service clearances, and move-in paths for equipment. For planning purposes, a room size of 0.75 SF per installed cooling ton can be used as a starting point. However, it should be noted that this value can increase or decrease once design commences based on the actual mechanical room's aspect ratio, number of heat exchangers/pumps, building structure layout, and other factors.

The mechanical room shall be provided with sufficient access for both personnel and equipment installation/removal. SAWS shall be provided with a key or keycard to facilitate 24/7/365 access to the mechanical room without escort, for the duration of the service agreement.

For mechanical rooms at ground level, provide a minimum 7 ft. x 3 ft. (or size needed to replace the largest piece of equipment) man-door accessible from the building exterior. For mechanical rooms below grade, provide a man-door with provisions (bollards, etc.) to ensure it cannot be blocked. If the equipment cannot fit through a single man-door, provide a double door or leave-out panels sufficiently sized to facilitate access.

The Customer is responsible for providing a weather-tight mechanical room, including sealing all openings, penetrations and associated waterproofing. All interior finishes, paint, and sealants for the mechanical room shall be provided by the Customer.

The mechanical room should be conditioned by the Customer and maintain a maximum space temperature of 75°F & 50% RH, and a minimum space temperature of 50°F. The equipment used to condition the mechanical room shall utilize chilled water from Customer (hot-side) of the chilled water system. The Customer is responsible for the terminal unit and its associated operation and maintenance. SAWS will not be responsible for any equipment failures that occur as a result of the space deviating from the allowable temperature range.

The Customer shall provide sufficient lighting (minimum 30 footcandles) for the mechanical room. Avoid installing lights where they will be obstructed by equipment or piping.

The Customer shall provide a potable water connection with code-required backflow prevention for initial filling and ongoing makeup water for the building chilled water system. Additionally, the Customer shall provide a hose bib on the interior wall adjacent to the heat exchangers 2 ft. AFF. A floor sink shall be provided adjacent to the heat exchangers to allow for heat exchanger drain-down and servicing.

5.2 Piping Requirements

The Customer is responsible for the entire ETS chilled water piping layout and design within the building. This includes the layout of the heat exchangers, valves, building pumps, control devices, terminal units, and all other inline components and appurtenances as outlined in this manual; as well as the coordination

of pipe elevations and pipe supports with other utilities and components within the mechanical room. The Customer's Contractor will install the heat exchanger's ETS cold-side piping per the Customer's construction documents and approved shop drawings and submittals. The Customer's Contractor will install the ETS hot-side piping and accessories. Refer to Appendix A.2.1 for the ETS Schematic and Section 10 for the scope breaks between the Customer and SAWS.

The ETS chilled water piping shall be ASTM A53, Grade B, ERW, Schedule 40, black steel pipe, with butt weld fittings, and welded and flanged joints. Long radius elbows and reducing tees shall be used (in lieu of weldolets) where commercially available. Piping shall be installed at right angles or parallel to building walls and be free of sags and bends. The piping installation shall be spaced to allow for the application of insulation and servicing of valves. Provide automatic air vents at high points and drains at low points.

The Customer is responsible for all ETS pipe support design and installation within the building, including shop drawings and submittals. SAWS assumes no liability for pipe support design, installation, or its resultant effect on building structure. The Customer's Contractor will install the ETS cold-side piping as directed on the Customer's construction documents and approved shop drawings and submittals.

Piping shall be supported independently from structure such that it is not transferring any load to the heat exchangers. Piping shall be supported such that inline components such as flow meters and control valves can be removed without the need for temporary supports.

5.2.1 Pipe Sizing

The chilled water piping shall be sized using best engineering practices and in compliance with the latest COSA adopted version of IECC and ASHRAE 90.1. The table below provides the recommended lateral pipe size and ETS pipe main size for various contract loads.

Table 2: ETS Pipe Sizing Guideline

Pipe Diameter (in.)	Min. Load (tons)	Max Load (tons)
4"	0	100
6"	100	300
8"	300	500
10"	500	800
12"	800	1,100
14"	1,100	1,550
16"	1,550	2,000
18" and above	Contact SAWS	

SAWS' service agreement requests a Customer Delta T of 15°F with a minimum of 12°F, with associated penalties for Delta Ts below 12°F and rebates for Delta Ts above 15°F. Refer to Appendix A.1.6 for Delta T Building Design Best Practices. A higher Delta T improves the overall DCS performance, lowering the cost of service for all customers.

5.3 Heat Exchanger Requirements

SAWS requires a minimum of two (2) heat exchangers for each Customer. While a heat exchanger has no moving parts and thus is unlikely to fail, they do require periodic maintenance (plate cleaning) to remove accumulated debris that can lead to fouling. Plate fouling increases pressure drop across the heat exchanger (raising required pump energy) and lowers the heat transfer efficiency and resultant Delta T.

Having a minimum of two heat exchangers allows for partial cooling capacity when one heat exchanger is out of service for maintenance. The Customer should make every effort to perform HX maintenance in the cooler months when cooling loads tend to be lower, but emergencies are always possible. To that end, SAWS recommends including a redundancy factor in the sizing of the heat exchangers. Table 2 below shows various levels of redundancy for a typical 1,000-ton customer load.

Table 3: Heat Exchanger Redundancy Options – 1,000-ton Contract Load Example

HX Redundancy	0%	25%	50%	50%	75%	100%
Contract Tons:	1,000	1,000	1,000	1,000	1,000	1,000
No. of HX's:	2	2	2	3	2	2
HX Capacity (each):	500	625	750	500	875	1,000
Total Installed Capacity (tons):	1,000	1,250	1,500	1,500	1,750	2,000
Relative Cost:	-	$	$$$	$$$$	$$$$	$$$$$
Redundancy:	None	Low	Medium	Medium	High	Highest

For most Customers, sizing the heat exchangers in the 25-50% redundancy range will result in a good tradeoff between equipment first cost, operational efficiency, and redundancy. It should be noted that while the added redundancy increases first cost, it also provides additional heat transfer area and improved heat transfer efficiency. For Customers with critical loads or consistently high base loads, higher redundancy rates (75%-100%) should be considered.

Table 4 below indicates the typical heat exchanger selection criteria. Refer to the Heat Exchanger specifications in Appendix A.4.14 for further requirements.

Table 4: Heat Exchanger Selection Criteria

HX Selection Criteria	
Capacity:	Varies per Customer
Cold Side Temperatures:	42°F supply / 57°F return
Hot Side Temperatures:	44°F supply / 59°F return
Flow Rate:	1.6 GPM/ton for 15°F Delta T
Pressure Drop:	7.5 PSI max
Design Pressure:	Varies per Customer (150 PSI standard, 300 PSI for high-rise)

5.4 Booster Pump Requirements

In all cases, the Customer will need to include booster pumps on the cold-side of the ETS to overcome any potential hydraulic losses of the Customer's piping and ETS. The booster pump (or multiple pumps depending on space availability and level of redundancy desired) should be installed on the chilled water supply line, downstream of the SAWS flow meter (see Appendix A.2.1 and Figure 2 below). The pump should be variable-speed and configured in parallel with a full-sized check valve bypass to permit flow without the pump if system pressure is adequate.

Predicated on the control sequence below, the booster pump should be selected assuming a differential pressure of zero (0) PSIG between the supply and return piping where the Customer's laterals tap off the SAWS mains in the ROW. Essentially, the booster pump should be sized to overcome the pressure drop through the entirety of the Customer's cold-side piping. The booster pump shall not pressurize the SAWS chilled water return line.

The following two-stage control is recommended to minimize booster pump runtime and provide a stable control loop between the booster pumps and HX control valves:

- Stage 1: Booster pump is off. The HX control valve modulates to maintain the building's chilled water supply temperature at setpoint [44°F (adj.)].
- Stage 2: If the HX control valve is 100% open and the building's chilled water supply temperature is [1.0°F (adj.)] above setpoint for a period of [5 minutes (adj.)], then start the booster pump. Booster pump speed modulates to maintain the building's chilled water supply temperature at setpoint. The HX control valve shall be 100% open whenever the booster pump is on. If the booster pump's VFD speed command is at minimum and the building's chilled water supply temperature is [0.5°F (adj.)] below setpoint for a period of [5 minutes (adj.)], turn the booster pump off and revert back to Stage 1.

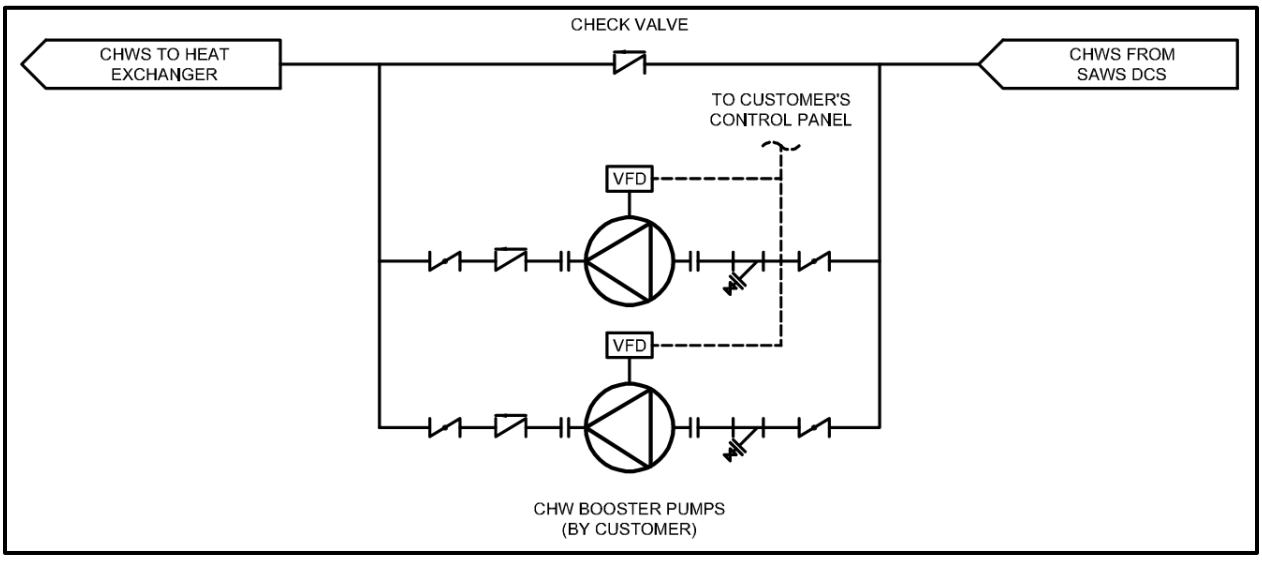


Figure 2 – Typical Booster Pump Configuration

5.5 Instrumentation & Control Requirements

SAWS will provide the ETS metering cabinet. The cabinet will measure and record the values used for Customer billing, namely the chilled water supply temperature, chilled water return temperature, and the chilled water flow rate. Additional measurements such as supply and return pressures will be logged for SAWS' control and diagnostics. The Customer's BMS will provide the control signal to the ETS control valves which will maintain the Customer building chilled water supply temperature at the desired setpoint.

The Customer shall provide a suitable location for the wall-mounted metering cabinet, with required clearances as outlined in Appendix A.2.14, as well as piping olets at SAWS-approved locations for the metering cabinet instrumentation. The metering panel and required clearance areas shall be clear of any piping, conduit, or other obstructions and receive ample lighting from the mechanical room lighting. The Customer shall also provide a dedicated 120-volt, 20-amp circuit, terminated at a junction box above the control panel. Ideally, this circuit should be on emergency power (if available). The Customer shall also provide a conduit pathway from the ETS room to the building exterior for SAWS' cellular antenna. The antenna and associated wiring will be installed by SAWS and allow for transmission of the metering data from the Customer site to SAWS. The antenna location will be site-specific and require coordination with SAWS Telecommunications group during the design phase to determine the optimal antenna placement on the building exterior.

For proper functionality, the control valves and flow meter shall be provided with sufficient upstream and downstream straight pipe diameters as outlined in the Appendix. The flow meter shall be a strap-on, ultrasonic type. The control valves shall be electrically actuated v-ball type. Two control valves in parallel arrangement shall be provided sized for 1/3 and 2/3 of the flow, respectively. For high redundancy, a single control valve at each heat exchanger can be utilized with SAWS approval.

The flow meter, temperature and pressure instruments, and metering cabinet will be furnished, installed and owned by SAWS.

5.6 Tenant Submetering (By SAWS Customer)

A common consideration for mixed-use and multi-tenant buildings utilizing district chilled water is the methodology used to equitably distribute the utility bill amongst the tenants. As noted above, SAWS metering and billing occurs at the building level (see Appendix A.1.2), and as such SAWS does not subdivide the chilled water bill down to the individual tenant level within a Customer building. The Customer is responsible for any submetering and individual tenant billing method they choose to implement.

There are various strategies for submetering individual tenant chilled water usage, including:

- Ratio Utility Billing System (RUBS): The least accurate, yet inexpensive and easiest to administer, is the RUBS method. This method assigns a proportional share of the utility bill, or allocation ratio, to each tenant. The allocation ratio is typically based on elements such as unit area, number of occupants, number of bedrooms/bathrooms, or other relevant metrics that can be used as proxies for chilled water consumption. The tenant's allocation ratio is simply multiplied by the total chilled water bill to determine each tenant's proportional share. This method is simple to implement and does not require any submetering equipment or related meter reading overhead cost. One downside of the RUBS method is since it is proportionally distributing the utility costs based on an allocation factor instead of on individual tenant's chilled water consumption habits, there is not a direct incentive for conservation nor feedback to the tenant on their energy usage.

- Flow Totalizer: A practical approach that provides decent equity at reasonable cost is to measure cumulative chilled water flow (in gallons) for each tenant and use the proportional share to allocate the total chilled water bill. Chilled water flow is a good proxy for overall load as it approximates tenant unit runtime and resultant cooling consumption. This method assumes uniform Delta T at each space, which is a reasonable assumption if similar style terminal units are used throughout the building. The flow totalizer can utilize a typical positive displacement water meter, similar to that used on domestic water service. This method requires meter reading prior to generating the tenant's chilled water bill. Overall, this is a popular method that provides a degree of Customer incentive and feedback on energy consumption at a reasonable cost.

- Thermal Energy Meter: The most accurate method, but also the most expensive to implement and maintain, is to provide a thermal energy meter (BTU meter) for each tenant. BTU meters measure a tenant's chilled water flow (in GPM) and Delta T to calculate real-time and cumulative chilled water consumption (in ton-hrs.) utilized by each tenant. A predetermined billing rate can be applied to the tenant's chilled water ton-hrs., or a tenant's proportional percentage of the building's overall ton-hrs. can be multiplied by the overall bill to determine their share. However, the cost to implement this type of system is high and requires ongoing overhead with meter reading, generating billing statements, and maintenance, such as periodic recalibration of temperature devices. SAWS uses BTU meters for billing its chilled water customers, but this may not be practical for buildings with many units at small tonnages.

Table 5: Comparison of Tenant Submetering Methods

Submetering Method	Accuracy / Equity	Implementation Cost	Billing Complexity	Meter Read Required
Ratio Based Utility System (RUBS)	Mediocre	N/A	Low	No
Flow Totalizer (Water meter)	Better	Low	Medium	Yes
Thermal Energy Meter (BTU meter)	Best	High	High	Yes

Regardless of which submetering method is used, a Customer billing solution will be required to generate billing statements on a monthly (or chosen interval) basis. This is relatively straightforward for the RUBS method as the allocation factor is fixed, whereas a monthly meter reading is required for the billing calculation for the Flow Totalizer and Thermal Energy Meter approaches. Meter readings can be performed manually or automatically. Manual meter readings may require access to the tenant space (depending on submeter location) and can introduce human error into the process. Automatic meter readings can be either wired or wireless, with integration into the building automation and/or billing software. While building management could opt to perform the meter reading and billing statements internally, there are several service providers available who provide turnkey metering and billing solutions.

Lastly, careful attention should be given to the control of the tenant's chilled water terminal unit(s), as it will be the tenant's aggregated Delta Ts that will determine the overall building's Delta T and resultant charges from SAWS. A 2-way modulating control valve is recommended. Refer to Appendix A.1.6 for Delta T best practices.

6. Construction Documents & Design Review Requirements

6.1 Construction Document Requirements

The Customer's EOR is responsible for developing the signed and sealed construction documents for the ETS and mechanical room. The construction documents set shall include the following:

- Site plan – Showing conflict-free routing of the chilled water laterals from the property line to the mechanical room, including proximity to other utilities, plan and profile views, with invert elevations.
- Overall mechanical floor plan – Overall plan showing mechanical room location with respect to the building and entry of chilled water laterals to the building.
- Enlarged mechanical room floor plan – minimum 1/4" scale, showing equipment arrangement with required clearances, piping layout with elevations noted, pipe supports, metering cabinet, instrumentation locations, and other mechanical room requirements identified in the CCS manual. Single-line piping will not be accepted beyond the 30% design submittal.
- Section views and isometric views of the mechanical room.
- Mechanical Details
- ETS Equipment Schedules
- Chilled Water Flow Diagrams and Control Diagrams
- Specifications – pertinent Div. 23 specifications that conform with SAWS CCS requirements.

The Customer shall split SAWS ETS scope onto separate drawing sheets for review purposes.

While the ETS will be designed to SAWS standards and ultimately constructed by the Customer, the Customer's engineer is the EOR and is the signing authority responsible for the construction documents, specifications, submittals, and RFIs.

6.2 Design Review Requirements

SAWS will review the Customer's ETS, mechanical room, and associated chilled water system design at the 30%, 60%, and 90% design milestones. The entire drawing set shall be provided to SAWS for continuity; however, SAWS will focus their review on the chilled water system and ETS.

It is understood that the 30% and 60% submittals will be progress versions of the final set. The 90% set shall be nearly complete with minimal outstanding items.

SAWS will work with the Customer to accommodate alternate deliverable milestones or accelerated project schedules. However, the Customer will be proceeding at their own risk by advancing the design without SAWS approval.

The Customer shall allow a minimum of ten (10) working days for SAWS' design review. At the end of the review period, SAWS will provide a written list of comments for the Customer's EOR response. The Customer's EOR shall provide written responses to the review comments. The Customer shall schedule a comment review meeting with SAWS and the Customer's EOR to review the comments and subsequent EOR responses.

7. Requirements During Construction

SAWS will install the chilled water laterals in the ROW and ETS metering cabinet and inspect the ETS within the Customer's limits of construction. As such, SAWS will require close coordination with the Customer's General Contractor (GC) for site access and scheduling of activities. SAWS will also be interfacing with the Customer's EOR for cursory submittal reviews, request for information (RFI), shop drawings, and other construction correspondence. SAWS desires for this to be a collaborative process with the Customer's GC and EOR to the ultimate benefit of the Customer.

7.1 Project Schedule

Generally, SAWS will install the chilled water laterals in the ROW first, followed by the Customer's GC installing the ETS piping once the mechanical room envelope has been constructed. SAWS cannot start on the ROW chilled water lateral construction until there is a signed service agreement.

Once the service agreement is executed, SAWS' Contractor will start to generate construction submittals and submit a construction schedule identifying durations for the chilled water laterals and metering cabinet installation. The Customer's GC is responsible for scheduling and incorporating SAWS installation activities into the overall construction schedule.

The overall construction schedule shall provide SAWS with uninterrupted timeframes for the CHW lateral and metering cabinet installation. SAWS' Contractor shall have dedicated access to their work zone without interference from other installing trades. The Customer shall provide SAWS with a mutually agreed upon start date and duration for the dedicated uninterrupted timeframe for SAWS installation scope.

The Customer shall be responsible for any schedule delays and associated costs due to delays or deviations from the agreed upon construction schedule.

7.2 Meetings

SAWS expects ongoing coordination with the GC during construction, including attendance at the construction kickoff meeting and recurring construction progress meetings.

Customer shall provide SAWS with a minimum of five (5) business days' notice for the kickoff meeting. The GC shall schedule the kickoff meeting once the Customer provides SAWS with the construction NTP. The purpose of the kickoff meeting is to review the process for installing the CHW laterals, metering cabinet and ETS, outline roles and responsibilities for each participant, identify points of contact and communication protocol, and determine any project or site-specific requirements (access, safety training, etc.). Meeting attendees should include: the Customer or designated representative, Customer's GC, Customer's EOR, SAWS district cooling representative, SAWS' Contractor, SAWS engineering, SAWS operations, and SAWS inspector.

Customer shall invite SAWS and its Contractor to the regular construction progress meetings, with the same attendee list as the kickoff meeting.

Given the nature of construction, it is understood that unscheduled meetings will occur. SAWS will make every effort to attend impromptu meetings, schedule and staff availability permitting.

7.3 Permitting

The Customer is responsible for obtaining all permits necessary for the ETS and chilled water laterals on the property.

7.4 Sitework & Access

The Customer's GC is responsible for ensuring SAWS' Contractor has unimpeded access to the job site and their respective work zone. This includes providing adequate staging and lay-down area on site to accommodate SAWS Contractor's equipment, materials, and tools to allow for a safe and adequate working area during the metering cabinet installation process.

The Customer's GC is responsible for providing a sufficient pathway to move material and equipment from the staging area and into the mechanical room. The GC shall ensure the travel path is appropriately designed and rated for the expected equipment loads.

7.5 Submittals & RFI's

The Customer's Contractor will generate product data, equipment submittals, and piping shop drawings based on the EOR's contract documents. SAWS will review compliance with the contract documents and SAWS CCS. The Customer's EOR will maintain responsibility as Engineer of Record for all submittal reviews and approval, and incorporate SAWS' review comments into the official response. The Customer's Contractor shall not commence construction without approved submittals from the Customer.

The Customer's Contractor will generate RFI's where needed to clarify scope and identify deviations or conflicts. SAWS will review compliance with the contract documents and SAWS CCS. The Customer EOR will be responsible for responding to any RFI's related to the chilled water scope.

Lastly, the Customer's Contractor will generate chilled water shop drawings. This will require coordination drawings from the GC including routing of other utilities in the mechanical room and location of pipe supports and attachment to structure. The Customer is responsible for the design of all pipe supports and their installation and attachment to structure. The Customer's Contractor shall not proceed with installation without approved pipe support drawings from the Customer EOR.

The Customer shall provide the necessary 2D and 3D (.dwg and .rvt, respectively) drawing files/models for the Customer's Contractor's piping shop drawing generation.

7.6 Pre-startup Requirements

Prior to connecting the Customer's piping to SAWS' chilled water laterals, the Customer shall complete the hydrostatic pressure test, cleaning/flushing, and passivation of the Customer's building piping (cold-side and hot-side), according to SAWS CCS requirements. The ETS heat exchangers shall be temporarily bypassed during these activities, and the entire building piping shall be passivated before connection to the chilled water laterals. SAWS reserves the right to witness these activities and requests a minimum of five (5) business days advanced notice for all tests. The Customer GC shall submit test reports for these activities to SAWS. Upon receipt of successful test results, and award of Substantial Completion (see next section), the ETS will be ready for start-up, followed by commencement of chilled water service.

8. Inspections & Project Closeout

8.1 Progress Inspections

During construction, SAWS maintains the right to perform periodic inspections of the mechanical room and ETS. SAWS will coordinate any inspections and site visits with the Customer.

8.2 Substantial Completion Inspection

Once the Customer's ETS and building chilled water system have been installed; the piping hydrostatic tested, flushed, and passivated; and the building chilled water pumps and control system energized; the system will be ready for an initial inspection. The Customer shall formally request the initial inspection from SAWS. It is recommended the Customer schedule this inspection a minimum of thirty (30) days prior to the chilled water need date.

During the initial inspection, SAWS will identify any outstanding mechanical room and ETS items needing correction or completion prior to commencing chilled water service. Refer to Appendix A.1.5 for a sample inspection checklist. The Customer's GC is responsible for rectifying their items in a timely fashion and notifying SAWS when ready for reinspection. After the reinspection is complete, the building chilled water system is cleared to be connected to the ETS. The Customer GC will make the final piping connection at the POD/POR scope break, and SAWS will open the isolation valves to allow chilled water flow to the Customer, which will designate the start of chilled water service (Operation Date) and initiate billing ramp up per the service agreement.

Once the building CHW system is connected to the ETS, SAWS can begin its installation of the metering cabinet. Upon completion, SAWS will perform functional testing of the metering cabinet, which will require the Customer's GC participation to operate the Customer ETS and related building-side equipment.

SAWS requires up to thirty (30) business days for completion of the metering system and related functional testing. The start-up testing is required prior to awarding Substantial Completion. The Customer GC shall include this duration in the overall construction schedule. After startup and Cx activities are complete, SAWS will deem the ETS as having reached Substantial Completion.

8.3 Final Acceptance

Following substantial completion, SAWS will perform one final inspection of the ETS and mechanical room. At this juncture, the ETS shall be utilizing permanent power and water, and the mechanical room shall be clean and free of debris.

Once the final inspection has been completed (with all outstanding items addressed to SAWS's satisfaction) and project closeout tasks are complete (see next section), SAWS will award Final Acceptance to the ETS.

8.4 Project Closeout

As part of the project closeout, the Customer's Contractor will submit electronic "as-built" drawings. The as-built drawings will be a marked-up PDF version of the contract documents indicating any field deviations. The EOR is responsible for incorporating the as-built drawings into record drawings. The Customer shall provide SAWS with a copy of the final record drawings.

The Customer's Contractor will generate and maintain the O&M manuals for the ETS, as well as maintain the warranty on any ETS components.

Lastly, the Customer shall provide SAWS with a key(s) or access card(s) required to facilitate 24/7/365 access to the ETS mechanical room. For the duration of the chilled water service agreement, SAWS reserves the right to perform inspections to ensure Customer is complying with CCS and service agreement requirements. The Customer shall make available upon request monthly chemical treatment reports to ensure the building piping system chemistry is compliant with the service agreement requirements.

8.5 Future Customer Modifications to the Chilled Water System

The Customer shall notify SAWS prior to undertaking any chilled water system modifications, such as building or ETS chilled water piping modifications or any planned outages requiring isolating the Customer's building from the SAWS loop.

For major chilled water piping modifications, the Customer shall provide SAWS at least ninety (90) days' notice. Similar to the ETS design process, SAWS reserves the right to review any design drawings for the proposed modification and provide comments, as well as perform construction submittal reviews and site inspections. Any modifications to the ETS are subject to the latest CCS requirements.

For building outages, the Customer shall provide SAWS at least 72 hours' notice. The building shall be isolated using the Customer's isolation valves. The Customer shall not operate the SAWS isolation valves in the ROW under any circumstances.

9. Typical Timeline of Activities

The following activities and durations are for a typical chilled water customer connection. Any timelines shown herein are for reference only and not guaranteed, as all projects will vary.

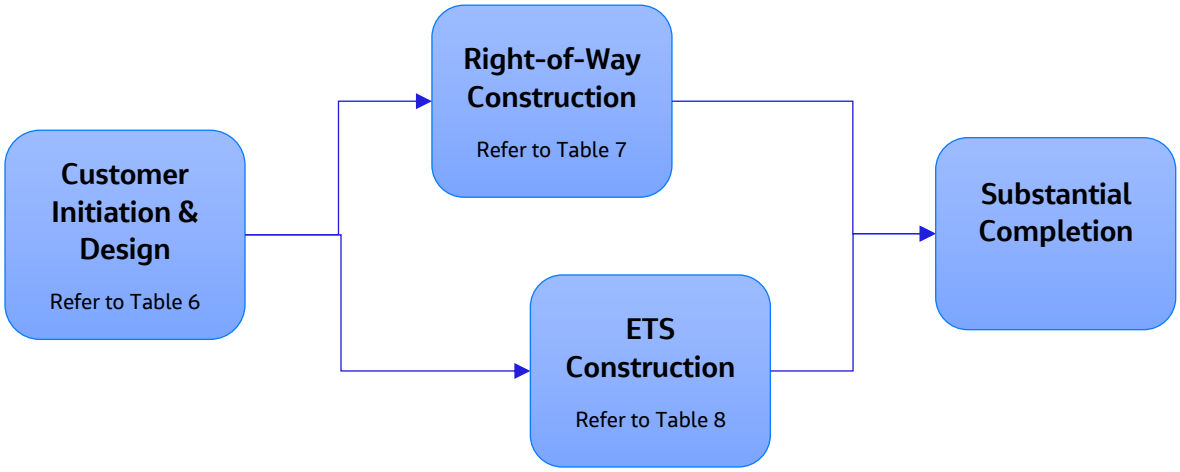


Figure 3 – Typical Project Timeline

Table 6 outlines the typical durations for new customer initiation, service agreement negotiation, and the customer's development of construction drawings for the ETS and adjoining site piping.

Table 6: SAWS ETS – Estimated Initiation & Design Durations

Activity	Estimated Duration
SAWS Performs LCCA	2 weeks
Customer Signs Letter of Intent (Optional)	-
Customer Reviews & Signs Service Agreement	4 weeks
Customer Issues ETS Construction Documents	26 weeks[1]
ETS Design Duration	**32 weeks**

Notes:

1. ETS Construction Document duration includes interim design progress submittals and associated SAWS design reviews.

Table 7 outlines the typical timeline for SAWS' design and construction of the underground chilled water piping in the ROW. The intent is to complete the underground piping installation prior to ETS start-up.

Table 7: SAWS Right-of-Way Piping – Estimated Construction Durations (Simple Connection[1])

Activity	Estimated Duration
SAWS ROW Design[2]	26 weeks
SAWS Procurement	12 weeks
Permitting	4 weeks
Submittal Generation & Review	4 weeks
Resubmittal Generation & Review (if needed)	4 weeks
Material Procurement	16 weeks
Site Construction	12 weeks
Start-up & Testing	2 weeks
Total Duration to Substantial Completion	**80 weeks**

Notes:

1. Simple Connection generally pertains to projects with favorable soil conditions, limited utility conflicts, and simple routing with minimal offsets/fittings.
2. This activity can occur concurrently with Customer ETS design.

Table 8 outlines the typical durations for the ETS construction. Actual durations will vary based on material availability, equipment lead times, and other market conditions.

Table 8: Customer ETS – Estimated Construction Durations

Activity	Estimated Duration
Customer's Contractor Procurement	8 weeks
Contractor Mobilization	2 weeks
Submittal Generation & Review	4 weeks
Resubmittal Generation & Review (if needed)	4 weeks
Material Procurement	16 weeks
ETS Installation	16 weeks
SAWS Metering Cabinet Installation	4 weeks
Start-up & Testing	2 weeks
Total Duration to Substantial Completion	**60 weeks**

10. Responsibility Matrix

The table below summarizes the roles, responsibilities, and scope breaks between the Customer and SAWS with respect to the design and construction of the chilled water laterals and ETS. This is best viewed in parallel with the ETS Schematic located in Appendix A.2.1. For the purposes of this table, "Customer" includes the Building Owner, their EOR, and Contractors. "SAWS" includes SAWS DCS personnel, engineers, operators, and Contractors.

The table has a column for each of the following activities:

- Specify & Design: Entity will serve as the EOR for the identified scope. Design shall comply with all SAWS standards.
- Review & Approve: Entity will review the identified scope for SAWS CCS compliance. Customer shall provide ample review period for SAWS. Customer is operating at their own risk by proceeding without SAWS approval. SAWS cursory review of Customer's drawings does not absolve the Customer of their internal quality control and code compliance responsibilities. **Note: Except for the ROW piping, the Customer's EOR is responsible for all permitting support, RFI's, and shop drawing construction submittal review. SAWS will provide cursory review only.**
- Purchase & Install: Entity responsible for procuring and installing the identified scope.
- Own & Maintain: Entity responsible for the operation, maintenance, and replacement (if needed) of the identified scope.

Table 9: Responsibility Matrix

Scope	Specify & Design	Review & Approve	Purchase & Install	Own & Maintain	Notes
Underground Piping from CHW main in ROW to Property Line	SAWS	SAWS	SAWS	SAWS	
Underground Piping from Property Line to mechanical room (including exterior penetration)	Customer	SAWS	Customer	Customer	Notes 1,2, 3
Mechanical Room	Customer	SAWS	Customer	Customer	Note 4
ETS - Design Layout	Customer	SAWS	Customer	Customer	Note 5, 6
ETS - Heat Exchangers	Customer	SAWS	Customer	Customer	
ETS - Cold-side piping and equipment to POD/POR	Customer	SAWS	Customer	Customer	Note 6, 7
ETS - Hot-side piping and equipment from POD/POR	Customer	Customer	Customer	Customer	Note 6, 7
ETS – Pipe supports	Customer	Customer	Customer	Customer	Note 6, 8
Identify Metering Cabinet Location	Customer	SAWS	SAWS	SAWS	Note 5
Metering Cabinet & Instruments	SAWS	SAWS	SAWS	SAWS	Note 9
Power to Metering Cabinet	Customer	SAWS	Customer	Customer	Note 10
Customer Building Controls (including ETS submetering)	Customer	Customer	Customer	Customer	Note 11

Notes:

1. Customer's site plan drawing will include a conflict-free site routing for the chilled water laterals within the property line. Customer will design, purchase & install, own & maintain these components.
2. Customer will design the pipe penetration through building exterior slab/wall, including the necessary sleeves and waterproofing. Customer will install the pipe through the sleeves, and the Customer will seal the penetration (linkseal or other means) and be responsible for the waterproofing.
3. Customer will allow and coordinate SAWS access within the limits of construction for inspection of site piping and Customer ETS.
4. Customer shall locate mechanical room on outside wall adjacent to the nearest chilled water main, at ground or basement level.
5. Design layout includes ETS piping, equipment, inline components, and metering cabinet location per SAWS standards.
6. Customer is responsible for permitting support, construction RFI's and submittals, and record drawings. SAWS will perform cursory review.
7. Refer to ETS Schematic - Appendix A.2.1.
8. Customer will be responsible for all pipe support and structural interface and design.
9. SAWS will design, install, and maintain the metering cabinet and associated instrumentation.
10. Customer will provide power to the Metering cabinet; a dedicated 120-volt, 20-amp circuit, terminated at a junction box above the control panel.
11. If Customer chooses to submeter, they will design, install, and own/maintain the instruments. SAWS will approve location.

Appendix A. Additional information

A.1 Document Templates

A.1.1 Typical Letter of Intent

Month Day, Year

Legal Entity Name of Customer (the "Customer")

Customer Representative Name
Property Name and Location (the "Premises")

Dear *Customer Representative Name*:

This is in response to your request for the availability of chilled water service to the above-referenced property. The location of the tract is within the City of San Antonio city limits and SAWS' existing *downtown* chilled water service area.

The San Antonio Water System ("SAWS") strives to provide quality, reliable service to its customers at a reasonable cost. Rates are kept low, in part, by having new customers pay for all costs associated with extending service to them (connection costs). City Ordinance 96794 established SAWS chilled water rates and the SAWS Board of Trustees' discretion to decide whether SAWS will participate in the construction of main extensions and installation of heat exchangers for each new customer on a case by case basis and accordingly add a fee for SAWS's recovery of costs related to such construction and installation (the "Capital Cost Recovery Fee").

The Capital Cost Recovery Fee shall be negotiated and agreed to by SAWS and the new customer based on the total cost, including interest, to design, construct and install the capital improvements that are necessary to provide chilled water services to the new customer. SAWS is willing to work with the new customer to amortize the Capital Cost Recovery Fee for a maximum term of twenty (20) years (subject to SAWS Board of Trustees approval); or, the new customer can pay to SAWS the Capital Cost Recovery Fee up-front. If a new customer chooses to take advantage of the Capital Cost Recovery Fee, all construction from the main to the heat exchangers will be performed by SAWS.

POTENTIAL CHILLED WATER DELIVERY TO THE PREMISES

In the event Customer enters into a chilled water services agreement with SAWS for chilled water service at the Premises, the chilled water will be supplied via an existing *XX-inch* chilled water main located on *Street Name*. This main is fed by two downtown chilled water plants, the Commerce St (900 E. Commerce) and Cherry St (725 S. Cherry) plants. From the SAWS main, a pair of *XX-inch* pipes will deliver the chilled water to customer heat exchangers at approximately 42 degrees Fahrenheit at sufficient flow to satisfy minimum connected load (*TBD*). Hydraulic de-coupling shall be maintained between SAWS' chilled water distribution system and the Customer building chilled water recirculation system by utilizing heat exchangers. The Customer shall not draw off any chilled water from the SAWS system and shall use best efforts to return chilled water to SAWS at a temperature not less than 57 degrees Fahrenheit.

The intent of this letter is to illustrate SAWS's intent to reserve *XXX tons* of cooling capacity for Customer and Customer's intent to accept from SAWS and pay SAWS for XXX tons of cooling capacity, in each case pursuant to a chilled water service agreement to be executed by SAWS and the Customer. This letter and associated capacity reservation will expire on the earlier to occur of: 1) ***date/time*** or 2) the date a definitive chilled water service agreement between Customer and SAWS is fully executed. However, this is a **non-binding** document; any and all actions taken or costs incurred (including design, engineering, procurement, construction, or development) by each party prior to the execution of a chilled water service agreement are at the sole risk of such party.

Prior to the development and execution of a chilled water service agreement, the following items (all subject to negotiation) need to be determined:

- Service Start Date
- Customer Contract Capacity (tonnage)
- Heat Exchanger Specifications (size, space requirements, pressure, etc.)
- Connection Details (piping route, costs, design/building responsibilities, etc.)
- Ownership of Connection Components (i.e. who owns pipe from SAWS main to HE)
- Access Terms (for SAWS O&M of HE, metering, and associated components)
- Design and Building Responsibilities/Timelines
- Connection Cost Payments (up-front vs amortized)
- Mechanical Room Specifications (HE space requirements, SAWS electrical needs for metering, etc.)

An estimate of the Customer's monthly chilled water bill and the current chilled water ordinance are included as attachments.

In no event shall Customer or any of its agents provide or participate in any public presentations or prepare or present any papers for public dissemination concerning this letter or the potential chilled water agreement with SAWS or with information obtained in connection with this letter or the potential chilled water agreement, without receiving the prior written approval from SAWS, which approval may be withheld in the sole and absolute discretion of SAWS.

Should additional information be needed, please contact me at email: christopher.wilcut@saws.org

Sincerely,

Chris Wilcut, CEM
Director – District Cooling & Energy Strategy
San Antonio Water System

Attachments
1. Chilled Water Bill Estimate
2. Ordinance 96794

A.1.2 Chilled Water Billing Structure (COSA Ordinance 2022-11-10-0869)

SZ
11/10/2022
Item # 6

ORDINANCE 2022-11-10-0869

APPROVING AN ADJUSTMENT TO THE SAN ANTONIO WATER SYSTEM (SAWS) CHILLED WATER DEMAND RATES FOR 2023 (12.0%) AND AUTHORIZING UP TO MAXIMUM ANNUAL PERCENTAGE ADJUSTMENTS FOR 2024 (12.0%), 2025 (10.0%), 2026 (8.0%) AND 2027 (8.0%) RESPECTIVELY; APPROVING TWO NEW CHILLED WATER RATE COMPENENTS, NAMELY A DELTA T ADJUSTMENT CHARGE AND A CAPACITY CHARGE RAMP UP SCHEDULE; AND AMENDING CHAPTER 34 OF THE CITY CODE AND PRIOR CITY COUNCIL ORDINANCES TO BE CONSISTENT HEREWITH.

* * * * *

WHEREAS, the San Antonio Water System ("SAWS") is a municipally owned utility of the City of San Antonio; and

WHEREAS, SAWS operates a Chilled Water System that provides air-conditioning service to customers in the Downtown area and Port San Antonio; and

WHEREAS, the Chilled Water System was originally created to serve Hemisfair in 1968 and its operation was consolidated into SAWS at its creation in 1992; and

WHEREAS, in 2000, the Port San Antonio Chilled Water System was also consolidated into SAWS; and

WHEREAS, Ordinance Nos. 96794 and 100588 established chilled water charges for the Downtown and Port San Antonio Chilled Water System; and

WHEREAS, the Chilled Water System functions by operating centralized water chilling plants and passing water chilled to near freezing through pipes to heat exchangers in customer buildings, which provide cooling for the customers' air handling systems; and

WHEREAS, such a system provides energy efficiency benefits and greenhouse gas emission reduction through a large-scale centralized system and shifting electrical demand off peak; and

WHEREAS, there are twenty-one customers on the Downtown System, with approximately 70% of the Chilled Water System serving the City of San Antonio, primarily for cooling the Alamodome and Convention Center and the balance of customers primarily include government offices and hotels; and

WHEREAS, the Port San Antonio Chilled Water System serves five customers including Boeing, Standard Aero, Chromalloy, United States Air Force, and Port San Antonio offices; and

WHEREAS, in July 2021, SAWS engaged a consultant to develop a long-term business and rate plan whose scope of work includes capital expenditures planning, financial planning, energy efficiency, controls/metering, management/staffing, hydraulic modeling, customer contracts, Port San Antonio analysis and marketing/communications; and

WHEREAS, SAWS has demonstrated that the Chilled Water System's net position has deteriorated and the current rates are not generating sufficient cash flow to fund needed capital improvements; and

WHEREAS, the SAWS Board of Trustees (the "Board") has recommended to the City Council that it approve a 12.0% increase for 2023 to the Chilled Water demand charge rates for the Downtown and Port San Antonio Chilled Water System to improve the financial condition of the System; and

WHEREAS, the Board has also recommended to the City Council that it approve additional up to maximum adjustments to the Chilled Water demand charge rates for the Downtown and Port San Antonio Chilled Water System for 2024 (12.0%), 2025 (10.0%), 2026 (8.0%), and 2027 (8.0%), respectively; and

WHEREAS, the Board has additionally recommended to the City Council that it approve two new chilled water rate components, namely a Delta T Adjustment Charge and a Capacity Charge Ramp Up Schedule; and

WHEREAS, the Supervisor of Public Utilities has reviewed the rate change request, considers it reasonable, and recommended approval of the rates and fees along with certain monitoring procedures; and

WHEREAS, in the exercise of its governmental regulatory authority, the City Council has determined that approval of the Board's requests are reasonable and necessary to ensure the financial sustainability and improvement of the Chilled Water System; **NOW THEREFORE:**

BE IT ORDAINED BY THE CITY COUNCIL OF THE CITY OF SAN ANTONIO:

SECTION 1. The City Council approves and authorizes a 12.0% adjustment to SAWS Chilled Water demand charge rates for the Downtown and Port San Antonio Chilled Water Systems effective on or about January 1, 2023, as set forth in Attachment I.

SECTION 2. The City Council approves and authorizes additional adjustments to the Chilled Water demand charge rates for the Downtown and Port San Antonio Chilled Water Systems for consumption effective on or about January 1, 2024, January 1, 2025, January 1, 2026, and January 1, 2027, respectively, up to the maximum rates set forth in Attachment I.

SECTION 3. The City Council approves and authorizes two new chilled water rate components, namely a Delta T Adjustment Charge and a Capacity Charge Ramp Up Schedule, effective on or about January 1, 2023, as set forth in Attachment I.

SECTION 4. The City Council approves and hereby adopts the accountability procedures set forth in Attachment II.

SECTION 5. The City Council finds that the adjustments and fees authorized and approved by this Ordinance are reasonable and necessary to ensure the financial sustainability and improvement of the Chilled Water System.

SECTION 6. Chapter 34 of the City Code of San Antonio, Texas (City Code), and prior City Council Ordinances regarding same, including but not limited to Ordinance Nos. 96794 and 100588, are hereby amended to be consistent with this Ordinance and its attachments including, the rate and fee schedules attached hereto and which are incorporated herein. Chapter 34 of the City Code is hereby amended by adding the language that is underlined (added) and deleting the language that is stricken (~~deleted~~) to the existing text as set forth in this Ordinance. All other provisions of Chapter 34 of the City Code shall remain unchanged and in full force and effect, unless expressly amended by this Ordinance.

SECTION 7. If any part, section, paragraph, sentence, phrase of word of this Ordinance is for any reason held to be unconstitutional, illegal, inoperative, or invalid, of if any exception to or limitation upon any general provision herein contained is held to be unconstitutional, illegal, invalid, or ineffective, the remainder of this Ordinance shall nevertheless stand effective and valid as if it had been enacted without the portion held to be unconstitutional, illegal, invalid, or ineffective.

SECTION 8. The publishers of the City Code of San Antonio, Texas are authorized to amend said Code to reflect the changes adopted herein and to correct typographical errors and to index, format and number paragraphs to the existing Code.

SECTION 9. Funding in the amount of $310,000.00 for this ordinance is available in Various Funds, Various Cost Centers and General Ledger 5407540 as part of the Fiscal Year 2023 Adopted Budget approved by City Council.

SECTION 10. Additional funding is contingent upon City Council approval of the Fiscal Year 2023 and subsequent budgets that fall within the contract terms of this ordinance.

SECTION 11. Payment is authorized to SAWS and should be encumbered with a purchase order.

SECTION 12. The financial allocations in this Ordinance are subject to approval by the Deputy Chief Financial Officer, City of San Antonio. The Deputy Chief Financial Officer may, subject to concurrence by the City Manager or the City Manager's designee, correct allocations to specific Cost Centers, WBS Elements, Internal Orders, General Ledger Accounts, and Fund Numbers as necessary to carry out the purpose of this Ordinance.

SECTION 13. This Ordinance is effective immediately upon the receipt of eight affirmative votes; otherwise, it is effective ten days after passage.

SZ
11/10/2022
Item # 6

PASSED AND APPROVED this 10th day of November, 2022.

M A Y O R
~~Ron Nirenberg~~

ATTEST:

Debbie Racca-Sittre, City Clerk

APPROVED AS TO FORM:

for

Andrew Segovia, City Attorney

City of San Antonio

City Council Meeting
November 10, 2022

2022-11-10-0869

6. Ordinance approving an increase to the Chilled Water demand charge rates for the San Antonio Water System (SAWS) for the downtown and Port San Antonio to improve the financial condition of the Chilled Water system effective on or about January 1, 2023, including the adoption of maximum "up-to" annual percentage adjustments to the Chilled Water demand charge rates for 2024, 2025, 2026 and 2027 respectively; authorizing two new Chilled Water rate components, a Delta T Adjustment Charge and a Capacity Charge Ramp Up Schedule, effective on or about January 1, 2023; and amending the City Code and Prior Ordinances to be consistent with the changes. [Ben Gorzell, Chief Financial Officer; Troy Elliott, Deputy Chief Financial Officer]

Councilmember Viagran moved to Approve. Councilmember Rocha Garcia seconded the motion The motion prevailed by the following vote:

Aye:	Nirenberg, Bravo, McKee-Rodriguez, Viagran, Rocha Garcia, Castillo, Cabello Havrda, Pelaez, Courage
Absent:	Sandoval, Perry

SZ
11/10/2022
Item # 6

ATTACHMENT I

Adjustments to Chilled Water Service Rate Schedules

SCHEDULE "A"
CHILLED WATER SERVICE RATE SCHEDULE FOR DOWNTOWN AREA
SAN ANTONIO WATER SYSTEM
San Antonio, Texas
Effective ~~January 1, 2022~~ January 1, 2023

Billings for chilled water service shall be produced on a monthly basis and shall consist of both a capacity charge and a commodity charge as follows.

CAPACITY CHARGE

~~The capacity charge shall be $20.24 per ton hour of demand.~~ The capacity charge for 2023 shall be $22.67 per ton hour of demand. For each year thereafter, effective on January 1 of each year from 2024 through 2027, respectively, the maximum allowable capacity charge amount per ton hour to be assessed shall be in accordance with the table below.

As of January 1 of each of the following years:	Maximum Allowable Capacity Charge per ton hour to be assessed:	Maximum Allowable Capacity Charge Annual Increase Percentage
2024	$25.39	12.0%
2025	$27.93	10.0%
2026	$30.16	8.0%
2027	$32.57	8.0%

The demand shall be the largest number of tons of cooling demanded in any of the twelve months ending with the month next preceding the month in which the bill is dated or the connected load specified in the contract with the customer, whichever is the greater of the two. The demand for the Alamodome, which is an event driven facility with occasional peaks in demand during off peak hours and long periods of low demand, shall be defined in a service agreement between the City of San Antonio and the San Antonio Water System to account for its unique and unpredictable demands on the chilled water system.

COMMODITY CHARGE

A commodity charge will be applied to the monthly metered consumption. The commodity charge will provide for the pass-through of the utility costs, including water and energy costs. No commodity charge shall be made if the metered use of the customer is zero (0) during the month.

The commodity charge will be computed as follows; all utility costs of the previous month will be recovered through an allocation to the consumption of the billing period. In addition, the payment to the city's general fund will be added where applicable.

Utility costs + Payment to general fund = Commodity charge consumption

CAPITAL COST RECOVERY FEE

In addition to any rates or fees adopted by the City Council that are related to the provision of chilled water services within the Downtown system, the SAWS Board of Trustees shall have the discretion to add a fee for the recovery of the capital costs related to the construction of main extensions and installation of heat exchangers to serve new customers. The addition of this Capital Cost Recovery Fee shall be negotiated and agreed to by SAWS and the new customer based on the total cost, including interest, to design, construct and install the capital improvements that are necessary to provide chilled water services to the new customer. An amortization schedule to recover these capital improvement costs shall have a maximum term of twenty (20) years. This Capital Cost Recovery Fee shall not include any infrastructure, fixtures, chattel or appurtenances that will be owned, operated or maintained by the new customer or the owner of the subject property. The SAWS Board of Trustees shall have the discretion to decide whether it will participate in the construction of a main extension and installation of heat exchangers on a case-by-case basis.

DELTA T ADJUSTMENT CHARGE

Delta T is defined as the difference in temperature between a customer's point of delivery and point of return and is an overall measure of system efficiency. This Delta T adjustment charge is applied to the Commodity Charge and represents the added or avoided energy costs. It provides a fee for a customer with low/poor Delta T or an incentive to those with high/good Delta T. A customer Delta T of 12 to 15 degrees will result in no Delta T adjustment. The Delta T adjustment to the Commodity Charge shall be calculated as the Commodity Charge multiplied by 6 percent for each degree (rounded to the nearest degree), in Fahrenheit, when the average return temperature is something other than 12 to 15 degrees. The Delta T adjustment will apply to the Commodity Charge for the months of April, May, June, July, August and September only. No Delta T adjustment shall be assessed until the later of January 1, 2024 or 12 months of establishing service, to allow a customer to optimize their water side system improvements.

CAPACITY CHARGE RAMP UP SCHEDULE

Beginning on the Operation Date (which may occur during construction), a new customer and SAWS may agree to the following schedule for phasing-in the Capacity Charge up to the Contract Capacity. Should the initial date the customer opens their building to the public (Opening Date) occur prior to the final month of the phase-in period below, the phase-in of the Capacity Charge shall no longer apply and billing for the Capacity Charge will begin in accordance with 100% of contracted capacity. Schedule included below:

- Month 1 (Operation Date): 10% of the Contract Capacity (or actual usage if more than 10%).
- Month 2: 20% of the Contract Capacity (or actual usage if more than 20%).
- Month 3: 30% of the Contract Capacity (or actual usage if more than 30%).
- Month 4: 40% of the Contract Capacity (or actual usage if more than 40%).
- Month 5: 50% of the Contract Capacity (or actual usage if more than 50%).
- Month 6: 60% of the Contract Capacity (or actual usage if more than 60%).
- Month 7: 70% of the Contract Capacity (or actual usage if more than 70%).
- Month 8: 80% of the Contract Capacity (or actual usage if more than 80%).
- Month 9: 90% of the Contract Capacity (or actual usage if more than 90%).

- Month 10: 100% of the Contract Capacity.

ADJUSTMENT FOR PAYMENT TO THE CITY GENERAL FUND

The City of San Antonio may change the percentage for payment to the city general fund pursuant to City Ordinance No. 75686, which is currently established at 4.0% of gross revenues. At that time, the commodity charge will be revised to include the new percentage of payment to the City of San Antonio.

DEFINITIONS

A ton is defined as 12,000 Btu's per hour.
An hour is defined as 60 consecutive minutes.
Gross Revenue is defined in City Ordinance No. 75686.

SCHEDULE "B"
CHILLED WATER SERVICE RATE SCHEDULE FOR PORT SAN ANTONIO
SAN ANTONIO WATER SYSTEM
San Antonio, Texas
Effective ~~January 1, 2022~~ January 1, 2023

Billings for chilled water service shall be produced on a monthly basis and shall consist of both a capacity charge and a commodity charge as follows.

CAPACITY CHARGE

The capacity charge for 2023 shall be ~~$25.57~~ $25.28 per ton hour of demand. For each year thereafter, effective on January 1 of each year from 2024 through 2027, respectively, the maximum allowable capacity charge amount per ton hour to be assessed shall be in accordance with the table below.

As of January 1 of each of the following years:	Maximum Allowable Capacity Charge per ton hour to be assessed:	Maximum Allowable Capacity Charge Annual Increase Percentage
2024	$28.31	12.0%
2025	$31.14	10.0%
2026	$33.63	8.0%
2027	$36.32	8.0%

The demand shall be the largest number of tons of cooling demanded in any of the twelve months ending with the month next preceding the month in which the bill is dated or the demand amount specified in the contract or agreement with the customer, whichever is the greater of the two.

COMMODITY CHARGE

A commodity charge will be applied to the monthly metered consumption. The commodity charge will provide for the pass-through of the Utility Costs, including water and energy costs. No commodity charge shall be made if the metered use of the customer is zero (0) during the month.

The commodity charge will be computed as follows: all utility costs of the previous month will be recovered through an allocation to the consumption of the billing period. In addition, the Payment to the City's General Fund will be added where applicable.

Utility Costs + Payment to General Fund = Commodity Charge Consumption

CAPITAL COST RECOVERY FEE

In addition to any rates or fees adopted by the City Council that are related to the provision of chilled water services within the Port San Antonio system, the SAWS Board of Trustees shall have the discretion to add a fee for the recovery of the capital costs related to the construction of main extensions and installation of heat exchangers to serve new customers. The addition of this Capital Cost Recovery Fee shall be negotiated and agreed to by SAWS and the new customer based on the total cost, including interest, to design, construct and install the capital improvements that are necessary to provide chilled water services to the new customer. An amortization schedule to recover these capital improvement costs shall have a maximum term of twenty (20) years. This Capital Cost Recovery Fee shall not include any infrastructure, fixtures, chattel or appurtenances that will be owned, operated or maintained by the new customer or the owner of the subject property. The SAWS Board of Trustees shall have the discretion to decide whether it will participate in the construction of a main extension and installation of heat exchangers on a case-by-case basis.

DELTA T ADJUSTMENT CHARGE

Delta T is defined as the difference in temperature between a customer's point of delivery and point of return and is an overall measure of system efficiency. This Delta T adjustment charge is applied to the Commodity Charge and represents the added or avoided energy costs. It provides a fee for a customer with low/poor Delta T or an incentive to those with high/good Delta T. A customer Delta T of 12 to 15 degrees will result in no Delta T adjustment. The Delta T adjustment to the Commodity Charge shall be calculated as the Commodity Charge multiplied by 6 percent for each degree (rounded to the nearest whole degree), in Fahrenheit, when the average return temperature is something other than 12 to 15 degrees. The Delta T adjustment will apply to the Commodity Charge for the months of April, May, June, July, August and September only. No Delta T adjustment shall be assessed until the later of January 1, 2024 or 12 months of establishing service to allow a customer to optimize their water side system improvements.

CAPACITY CHARGE RAMP UP SCHEDULE

Beginning on the Operation Date (which may occur during construction), customer and SAWS may agree to the following schedule for phasing-in the Capacity Charge up to the Contract Capacity. Should the initial date the customer opens their building to the public (Opening Date) occur prior to the final month of the phase-in period below, the phase-in of the Capacity Charge shall no longer apply and billing for the Capacity Charge will begin in accordance with 100% of contracted capacity. Schedule included below:

- Month 1 (Operation Date): 10% of the Contract Capacity (or actual usage if more than 10%).
- Month 2: 20% of the Contract Capacity (or actual usage if more than 20%).
- Month 3: 30% of the Contract Capacity (or actual usage if more than 30%).
- Month 4: 40% of the Contract Capacity (or actual usage if more than 40%).
- Month 5: 50% of the Contract Capacity (or actual usage if more than 50%).
- Month 6: 60% of the Contract Capacity (or actual usage if more than 60%).
- Month 7: 70% of the Contract Capacity (or actual usage if more than 70%).
- Month 8: 80% of the Contract Capacity (or actual usage if more than 80%).
- Month 9: 90% of the Contract Capacity (or actual usage if more than 90%).

- Month 10: 100% of the Contract Capacity.

ADJUSTMENT FOR PAYMENT TO THE CITY GENERAL FUND ~~AND TO GKDA~~

The City of San Antonio may change the Percentage for payment to the City General Fund pursuant to City Ordinance No. 75686, which is currently established at 4.0% of Gross Revenues. At that time, the commodity charge will be revised to include the new Percentage of Payment to the City of San Antonio.

DEFINITIONS

A ton is defined as 12,000 Btu's per hour.
An hour is defined as 60 consecutive minutes.
Gross revenue is defined in City Ordinance No. 75686.

SZ
11/10/2022
Item # 6

ATTACHMENT II

Accountability Procedures

Accountability Procedures

Chilled Water System - Ongoing evaluation will continue to ensure that the pre-approved 5-year rate plan from January 1, 2023, through 2027 is reasonable and necessary for SAWS chilled water system and its customers. SAWS shall:

1. Provide quarterly financial reports on the Chilled Water System including
    a. Sources and uses update with year-to-date tracking to budget
    b. Progress on capital plan
    c. Detailed status of marketing efforts
2. Develop a detailed plan addressing the recommendation from the Chilled Water consultant's report,
3. Perform customer outreach on the plan to include existing and potential growth customers in both Downtown and PortSA.
4. Update the plan for growth scenarios based on the customer feedback.
5. At least sixty days prior to the implementation of any previously approved "up-to" rate increase under the rate plan, SAWS will provide to the City's Public Utilities Division:
    a. The proposed increase and the calculation method,
    b. Underlying support for the increase, including sources and uses that illustrate the need for the proposed increase, and
    c. Any additional information requested by the City's Public Utilities Office
6. Annual adjustments under the pre-approved "up-to" maximum amounts require concurrence of the Supervisor of Public Utilities.

A.1.3 Typical Customer Agreement

CHILLED WATER SERVICE AGREEMENT

THE STATE OF TEXAS §
COUNTY OF BEXAR §

This utility services agreement (the "Contract") is made as of _____ _____ , 20__ for the purchase of chilled water service between _____, a _____, herein called "CUSTOMER" , and the San Antonio Water System Board of Trustees, a water, wastewater, and water recycling agency of the City of San Antonio established and created pursuant to the provisions of Ordinance No. 75686 and the Texas Revised Civil Statutes Annotated Article 1115, hereinafter referred to as "SAWS," SAWS and CUSTOMER agree as follows:

1. **SERVICE STATEMENT**

The purpose of this Contract is to specify the rights, duties, and responsibilities of the parties in relation to the chilled water services provided by SAWS to the CUSTOMER at that certain property known as the _____ located at _____ in San Antonio, Bexar County, Texas.

(a) The CUSTOMER shall purchase from SAWS and SAWS shall sell to the CUSTOMER chilled water service.

(b) SAWS-owned and CUSTOMER-owned facilities shall be maintained by each party in accordance with best engineering practices.

(c) Service delivery and hydraulic de-coupling shall be provided between SAWS chilled water distribution system and CUSTOMER building chilled water circulating system by use of heat exchangers (Service Equipment) located within CUSTOMER facility. The CUSTOMER point of delivery (POD) and point of return (POR) is at the underground lateral piping flange breaks at the property line.

(d) Now therefore, in consideration of the mutual covenants herein contained, the sufficiency and adequacy of which the Parties acknowledge, the Parties agree to the following:

2. DEFINITIONS

(a) "Contract Demand (Capacity)" means the capacity set forth in paragraph 9 (a), as adjusted per this Agreement's terms.

(b) "Operation Date" means the date of commencement of chilled water service.

(c) "ETS" means the equipment and system owned by CUSTOMER used to **hydraulically de-couple CUSTOMER water from SAWS' water in the** delivery of service to the CUSTOMER.

(d) "Service Point" means the point at which chilled water is delivered to the CUSTOMER (POD) and the point at which CUSTOMER returns chilled water (POR) to SAWS.

(e) "Customer Design Return Temperature" means the chilled water supply temperature (approximately 42 degrees) plus 15 degrees.

Capitalized terms not defined herein shall be given the meaning assigned to them under City Council Ordinance Number 2022-11-10-0869.

3. CUSTOMER AGREES TO ACCEPT CHILLED WATER

(a) CUSTOMER warrants and represents that it has the power and authority to enter into and perform this Contract, which shall be a valid and binding obligation of CUSTOMER and enforceable in accordance with its terms.

(b) CUSTOMER agrees to: (i) operate its systems in a safe and compatible manner with SAWS central production and distribution facilities; and (ii) maintain clean water and water chemistry to industry standards and to provide reports as requested by SAWS of the water chemistry analysis.

(c) CUSTOMER agrees that SAWS shall have no responsibility for the use, handling, or action of chilled water, nor any liability for anything which may be done, happen or arise with respect to any of them between the said two service valve points.

(d) CUSTOMER may resell Service only to a co-owner, manager, or tenant of the Premises; provided such resale does not subject SAWS to any governmental rules, regulation, laws, or taxes to which it was not otherwise subject. Regardless of any

such resale, CUSTOMER remains primarily liable to SAWS for all costs and charges payable under this Agreement. CUSTOMER shall pay all taxes or governmental charges arising from its resale of Service. SAWS will not provide any submetering of Service under this Agreement.

(e) The CUSTOMER shall use best efforts to return all chilled water to SAWS at POR at 57 degrees Fahrenheit.

(f) The CUSTOMER shall not draw off any chilled water from the SAWS system.

(g) The CUSTOMER grants SAWS the right, upon notice to the CUSTOMER, to interrupt service to make repairs to the system. SAWS will use best efforts to schedule repairs to minimize service interruption and inconvenience to CUSTOMER.

(h) Notwithstanding the foregoing, as a condition of service, CUSTOMER hereby grants SAWS the right of access onto CUSTOMER's property for the purpose of installing, maintaining, operating, inspecting, repairing and replacing SAWS' metering cabinet and related equipment.

(i) The CUSTOMER has received SAWS' District Cooling System Customer Connection Standards document and agrees to abide by those standards.

(j) CUSTOMER agrees that all of the system in CUSTOMER building and on Customer premises including the Service Equipment, in mechanical room, to the POD and POR at property line, except SAWS' metering devices, shall be owned, installed, controlled, maintained, repaired, and replaced by CUSTOMER.

(k) CUSTOMER shall be responsible for the design and construction of the Service Equipment mechanical room in its entirety and for chilled water lines extending to the POD and POR at the Property Line. Design of mechanical room shall be coordinated with and be acceptable to SAWS. The mechanical room shall include: (1) adequate clearance, unobstructed space, lighting, and HVAC to protect all Service equipment and provide for safe maintenance and operation thereof; and (2) electrical connections at the metering place consisting of a dedicated 120-volt, 20-amp circuit in a dedicated continuous 1.5" EMT conduit, terminated in a 12x12 metal junction box to SAWS control cabinet. The electrical connection and service shall be provided and maintained in service at no cost to SAWS. CUSTOMER shall provide SAWS with isometric shop drawings of the mechanical room upon

completion. The CUSTOMER shall complete construction of the mechanical room no later than 90 calendar days prior to the Operation Date.

(l) If applicable, the CUSTOMER will grant, or cause to be granted to SAWS, without cost and unburdened by improvements, an easement which upon request by SAWS shall be defined by an instrument in recordable form or an acceptable license for a period not less than the term of this Contract in and across the CUSTOMER'S site for pipelines to serve the CUSTOMER. SAWS will restore the surface of easements or licensed areas to the condition prior to excavation after installing, replacing, repairing, or maintaining its pipeline and facilities.

(m) Construction Timing and Progress Reporting. CUSTOMER shall involve SAWS in planning discussions to coordinate construction and installation of SAWS chilled water facilities with any other related construction activities on the Premises. During construction and installation of the chilled water facilities, Customer shall provide SAWS: (i) a detailed monthly progress report describing the status of CUSTOMER'S construction and installation activities, including any system testing results, and estimating the date CUSTOMER will be ready to receive Service and (ii) a detailed construction schedule including the dates and times scheduled for SAWS's installation of metering cabinet and connections to pipe mounted field monitoring devices on the CUSTOMER'S site.

4. SAWS AGREES TO DELIVER CHILLED WATER

(a) SAWS shall extend its existing chilled water system, including main and lateral lines, to the coordinated location at CUSTOMER property line.

(b) SAWS agrees to install and own a metering cabinet, metering field devices and provide connectivity from the panel to the required pipe mounted field devices.

(c) SAWS shall use best efforts to deliver to CUSTOMER'S premises, at the point of delivery POD, chilled water at an approximate temperature of 42 degrees Fahrenheit and at sufficient flow to meet the connected load as specified in Paragraph 9 (a) of this Contract providing the CUSTOMER return temperature conditions are met at POR as specified in Paragraph 3 (e) of this Contract.

5. METERING

(a) SAWS shall furnish, install, and maintain the necessary metering devices for chilled water services on the CUSTOMER'S premises. Such metering devices shall remain the property of SAWS.

(b) All books and records pertaining to this Contract, including, meter and testing records, will be open and available during normal business hours for copying, inspection, and audit by CUSTOMER and SAWS, with prior reasonable notice. CUSTOMER may, at its own expense, install check meters on chilled water delivered so long as those check meters do not interfere with the operation and maintenance of SAWS' infrastructure and meters.

(c) CUSTOMER shall allow SAWS access to metering cabinet and metering devices as deemed needed by SAWS. CUSTOMER shall provide SAWS with a way to access metering equipment at all times, whether by providing a key or other.

6. CESSATION OF CHARGES

(a) In the event the CUSTOMER'S premises should be destroyed by fire or other hazard or voluntarily razed, CUSTOMER shall be liable for all charges incurred to the date of such occurrence but shall not be obligated for Capacity and Commodity charges subsequent to such occurrence, except as provided in subparagraph (c) of this Paragraph and Paragraph 7 (c) below. CUSTOMER will be responsible to continue paying the Capital Cost Recovery Fee.

(b) When a CUSTOMER'S premises have been destroyed or razed, charges shall resume only if the same structure shall be rebuilt or another structure using cooling facilities be erected by the CUSTOMER in the same or essentially the same location.

(c) When a force majeure event prevents SAWS from performing for a period exceeding 30 days and CUSTOMER provides temporary services from othersources, then all Charges will resume only after restoration of service has been accomplished.

7. RATE AND BILLING

(a) The CUSTOMER shall pay SAWS not later than the due date specified in the statement for chilled water service in accordance with the schedule of rates as established by Ordinance of the City Council of the City of San Antonio. Such rates will be charged until modified or changed by appropriate action of the City Council of the City of San Antonio in which event the rates as changed will apply.

(b) Customer agrees that the Operation Date is _____. The Operation Date may be modified by mutual agreement of both parties.

(c) The CUSTOMER agrees that upon Operation Date it shall pay SAWS a monthly Capacity Charge for chilled water based on the current rate for chilled water service, as set by the City of San Antonio City Council, multiplied by the Contract Demand specified in Paragraph 9 (a) of this Contract. This rate is set by the City of San Antonio City Council.

(d) The CUSTOMER agrees that upon the Operation Date it shall pay a monthly Capital Cost Recovery Fee to recover the unique costs of extending SAWS system to the CUSTOMER. It includes distribution piping and all necessary construction and demolition to connect the distribution piping from the existing DCS system to the CUSTOMER, and metering. These costs are recovered over a 20-year period. The fixed monthly Capital Cost Recovery Fee is _____, which shall begin on _____ and end on _____.

(e) CUSTOMER agrees that upon Operation Date it shall pay SAWS a Commodity Charge for chilled waterservice based on CUSTOMER's monthly consumption, in ton-hours, as a pro rata share of the overall system total ton-hours delivered as a pass through of costs for electric, water, and wastewater. No commodity charge shall be made if the metered use of the CUSTOMER is zero (0) during the month.

(f) If a billing meter system fails to provide useable consumption readings for a period, SAWS will use best engineering practices to estimate consumption of service for that period. These practices may include estimating consumption based upon usage immediately before and immediately after that period, average daily consumption or

metered consumption for that period from other comparable buildings.

(g) CUSTOMER has been provided 'Building Design Best Practice" guide as an Appendix in SAWS District Cooling System-Customer Connection Standards. CUSTOMER agrees to a Delta T adjustment to the Commodity Charge. Delta T is defined as the difference in temperature between the CUSTOMER'S POD and POR and is an overall measure of system efficiency. Lower delta T's require more water flow to deliver the same cooling tonnage, resulting in the need for larger piping, larger pumps, and overall higher DCS energy consumption. Conversely a higher delta T results in a lower DCS energy consumption. This Delta T adjustment is added to the Commodity Charge and represents the added or avoided energy costs. It provides a penalty to a CUSTOMER with low/poor delta T or an incentive to those with high/good delta T. A CUSTOMER delta T of 12 to 15 degrees will result in no Delta T adjustment. The Delta T adjustment to the Commodity Charge shall be calculated as the Commodity Charge multiplied by 6 percent for each degree, in Fahrenheit, the average return temperature is something other than 12 to 15 degrees. The Delta T adjustment will apply to the Commodity Charge for the months of April, May, June, July, August, and September only. SAWS agrees to waive the Delta T adjustment for the first 12 months of service from the Operation Date to allow customer to address their water side system improvements.

(h) RAMP UP CHARGES: Beginning on the Operation Date (which may occur during construction), CUSTOMER and SAWS agree to the following schedule for phasing-in the Capacity Charge up to the Contract Capacity. Should the initial date CUSTOMER opens their building to the public (Opening Date) occur prior to the final month of the phase-in period below, the phase-in of the Capacity Charge shall no longer apply and billing for the Capacity Charge will begin in accordance with 7 (c) above. Monthly Capacity Charge will be based on the below ramp up schedule or actual peak capacity taken, whichever is greater.

- Month 1 (Operation Date): 10% of the Contract Capacity (or actual usage if more than 10%)
- Month 2: 20% of the Contract Capacity (or actual usage if more than 20%)
- Month 3: 30% of the Contract Capacity (or actual usage if more than 30%)
- Month 4: 40% of the Contract Capacity (or actual usage if more than 40%)

- Month 5: 50% of the Contract Capacity (or actual usage if more than 50%)
- Month 6: 60% of the Contract Capacity (or actual usage if more than 60%)
- Month 7: 70% of the Contract Capacity (or actual usage if more than 70%)
- Month 8: 80% of the Contract Capacity (or actual usage if more than 80%)
- Month 9: 90% of the Contract Capacity (or actual usage if more than 90%)
- Month 10: 100% of the Contract Capacity

8. TERM.

The term of this Contract shall begin upon the Operation Date and shall continue for a primary term of twenty (20) years and thereafter for two (2) five (5)-year renewal periods each, unless terminated by either party on twelve (12) months written notice prior to date of renewal of any renewal period. This Contract may be terminated by SAWS at any time upon the expiration of thirty (30) days after notice to CUSTOMER for nonpayment of services. If this contract is terminated by either party before the CUSTOMER has paid the total amount of the Capital Cost Recovery Fee as described in 7 (d) above, then the CUSTOMER will be responsible for any unpaid balance of the Capital Cost Recovery Fee at the time of termination. Notice to CUSTOMER shall be in writing and delivered by first-class mail.

9. CONNECTED LOADS – CONTRACT DEMAND (3)

(a) The number of tons of connected chilled water load (Contract Demand/Capacity) is ____ tons.

(b) The demand shall be the largest number of tons of cooling demanded in any of the twelve months ending with the month next preceding the month in which the bill is dated or the demand amount specified in the contract or agreement with the customer, whichever is the greater of the two.

(c) Customer may request to increase Contract Demand and SAWS will make best efforts to adjust, however SAWS cannot guarantee the availability of said demand increase. Customer may request to reduce Contract Demand and SAWS will make best efforts to adjust once SAWS has contracted that reduced amount with another

customer.

10. DEFAULT

In the event of default by CUSTOMER, this Contract shall not be terminated until thirty (30) days after written notice of such default is delivered to CUSTOMER at the premises and upon SAWS being provided notice thereof, to the holder of any first mortgage on the CUSTOMER'S interest in the premises at such address as such first mortgage holder shall furnish to SAWS. In the event of default by CUSTOMER, CUSTOMER'S Mortgagee shall have until thirty (30) days after receipt of written notice of such default to cure such default. As CUSTOMER is an agent of OWNER, notice to CUSTOMER shall be deemed to be notice to OWNER for purposes of any notice provision required in this Contract.

11. NOTICES

Notice to the parties shall be considered to have been properly given, if given by first class mail, postage prepaid at the addresses shown below, or at such other addresses as the parties shall have previously indicated in writing

CUSTOMER: _____
_____
_____
_____

SAWS: San Antonio Water System
Contract Administration
Attn: Diana Woltersdorf
2800 US Hwy 281 North
P.O. Box 2449
San Antonio, Texas 78298-2449

12. NO BENEFIT OR GIFT TO SAWS

CUSTOMER shall not offer, confer, or agree any benefit or gift to any SAWS employee.

13. ASSIGNMENT

This Contract may be assigned by CUSTOMER with the written consent of SAWS, which consent shall not be unreasonably withheld. SAWS has the unconditional right, subject to City Council approval, and after delivery of written notice to CUSTOMER of the effective date, to assign, transfer or delegate any and all rights, duties, and obligations under this Contract to any person or entity at any time during the term of this Contract. SAWS also has the unconditional right, subject to City Council approval, and after delivery of written notice to CUSTOMER of the effective date, to grant, sell, transfer, convey and/or assign its ownership interest in its chilled water system to any person or entity at any time during the term of this Contract.

14. ENTIRE AGREEMENT

This Contract constitutes the entire agreement and supersedes all prior agreements and understandings between the parties concerning the subject matter of this Contract. No rights under this Contract may be waived and no modification, change or amendment to this Contract shall be made except by written agreement executed by the parties.

15. WAIVER

The failure on the part of SAWS at any time to require the performance by CUSTOMER of any portion of this Contract shall not be deemed a waiver of or in any way affect SAWS's right to enforce such provision or any other provision. Any waiver by SAWS of any provision hereof shall not be taken or held to be a waiver of any other provision hereof or any other breach hereof.

16. SEVERABILITY

The invalidity or non-enforceability of any provision of this Contract shall not affect the validity or enforceability of any other provision of this Contract. If one or more of the provisions hereof shall for any reason be held to be invalid, illegal, or unenforceable in any respect under applicable law, such invalidity, illegality, or unenforceability shall not affect any other provisions hereof, and this Contract shall be construed as if such invalid, illegal, or unenforceable provision had never been contained herein.

17. JOINTLY AND SEVERALLY LIABLE

If the CUSTOMER and OWNER are different entities, then they shall be jointly and severally liable for the performance of their respective obligations that arise under this Contract.

18. CUMULATIVE REMEDIES

In the event of default by CUSTOMER under this Contract, SAWS shall have all rights and remedies afforded to it at law or in equity to enforce or interpret the terms of the Contract. The exercise of any one right or remedy shall be without prejudice to the enforcement of any other right or remedy allowed at law or in equity.

19. SUCCESSORS AND ASSIGNS

CUSTOMER hereby binds itself, its heirs, executors, administrators, other legal representatives, successors and assigns for the faithful and full performance of the terms and provisions of this Contract.

20. CUSTOMER INDEMNIFICATIONS OBLIGATIONS

CUSTOMER SHALL PROTECT AND INDEMNIFY SAWS FROM CUSTOMER'S FAILURE TO PROPERLY AND SAFELY HANDLE THE CHILLED WATER. CUSTOMER, THEREFORE, AGREES TO AND SHALL INDEMNIFY, HOLD HARMLESS AND DEFEND SAWS AND THE CITY OF SAN ANTONIO, THEIR OFFICIALS, OFFICERS, AGENTS, SERVANTS AND EMPLOYEES, FROM AND AGAINST ANY AND ALL CLAIMS, LOSSES, DAMAGES, JUDGMENTS, CAUSES OF ACTION, SUITS AND LIABILITY OF EVERY KIND, INCLUDING ALL EXPENSES OF LITIGATION, COURT COSTS AND ATTORNEYS' FEES, FOR INJURY TO OR DEATH OF ANY PERSON, OR FOR DAMAGE TO ANY PROPERTY, ARISING OUT OF OR IN CONNECTION WITH THE SALE, TRANSFER, DELIVERY, ACCEPTANCE, PURCHASE, USE, HANDLING AND/OR RETURN OF CHILLED WATER UNDER THIS CONTRACT. ALL INDEMNITIES CONTAINED IN THIS CONTRACT SHALL SURVIVE THE TERMINATION HEREOF.

21. FORCE MAJEURE

Neither party shall be considered to be in default with respect to any obligation hereunder, other than the obligation of a party to pay sums of money due to the other party under or pursuant to this Contract, if failure of performance shall be due to force majeure. The obligation to pay money in a timely manner is absolute and shall not be subject to force majeure provisions. If either party is affected by a force majeure event, such party shall immediately within reason give notice to the other party stating the nature of the event, its anticipated duration and any action being taken to avoid or minimize its affect. The suspension of performance shall be of no greater scope and no longer duration than is reasonably required and the non-performing party shall use its best efforts to remedy its inability to perform.

For purposes of this Contract, force majeure shall mean the occurrence of any of the following events beyond the control of a party hereto, which results in the failure or delay by that party of some performance mandated by this Contract: failure due to fire, earthquake, flood, storm, lightning, epidemic, war, riot, civil disturbance, sabotage, strike or labor difficulty, accident or casualty to equipment, unavailability of replacement equipment, inability to maintain required authorizations from governmental bodies or restraint, order or decree by court or public authority.

22. SURVIVAL

Any and all representations, conditions and warranties made by CUSTOMER under this Contract are of the essence of this Contract and shall survive the execution, delivery and termination of it, and all statements contained in any document required by SAWS, whether delivered at the time of the execution, or at a later date, shall constitute representations and warranties hereunder.

23. GOVERNING LAW

This Contract is governed by the laws of the State of Texas and all obligations of the parties under this Contract are performable in Bexar County, Texas. Venue for any action or proceedings arising under or pertaining to this Contract (including those that may arise under Federal Law) shall be exclusively in Bexar County, Texas.

24. HEADINGS

All headings in this Contract have been inserted for convenience reference only and shall not in any manner be construed as modifying, amending, or affecting in any way the express terms and provisions hereof.

25. COUNTERPART EXECUTION

This Contract may be executed in duplicate original counterparts, and each counterpart shall have the full force and effect of an original, fully executed instrument.

EXECUTED in duplicate originals as of the date first above written.

CUSTOMER/OWNER:

_____

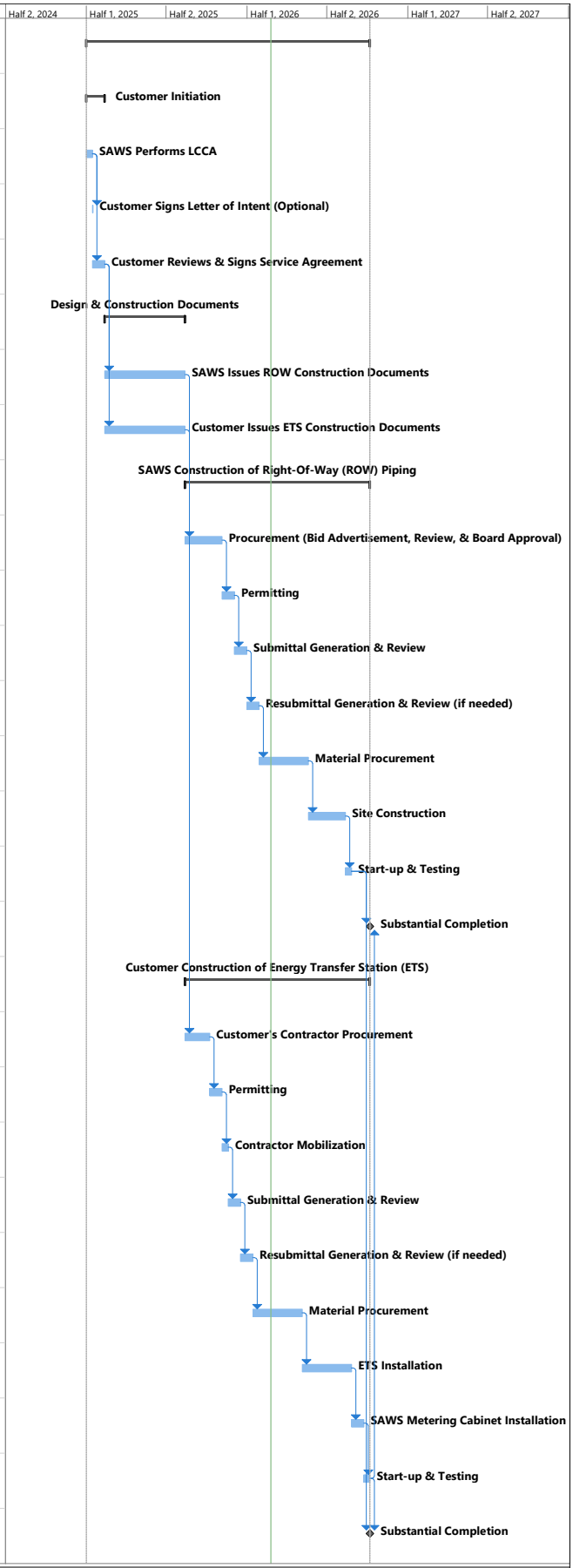
By: _____
Title: _____
Date: _____

SAN ANTONIO WATER SYSTEM

By: _____
Name: Diana Woltersdorf
Title: Director – Contracting
Date: _____

A.1.4 Typical Project Schedule

ID	Task Name	Duration	Predecessors
1	**SAWS Customer Connection**	**92 wks**	
2	**Customer Initiation**	**6 wks**	
3	SAWS Performs LCCA	2 wks	
4	Customer Signs Letter of Intent (Optional)	1 day	3
5	Customer Reviews & Signs Service Agreement	4 wks	3
6	**Design & Construction Documents**	26 wks	
7	SAWS Issues ROW Construction Documents	26 wks	5
8	Customer Issues ETS Construction Documents	26 wks	5
9	**SAWS Construction of Right-Of-Way (ROW) Piping**	**60 wks**	
10	Procurement (Bid Advertisement, Review, & Board Approval)	12 wks	7
11	Permitting	4 wks	10
12	Submittal Generation & Review	4 wks	11
13	Resubmittal Generation & Review (if needed)	4 wks	12
14	Material Procurement	16 wks	13
15	Site Construction	12 wks	14
16	Start-up & Testing	2 wks	15
17	Substantial Completion	0 wks	16,27
18	**Customer Construction of Energy Transfer Station (ETS)**	**60 wks**	
19	Customer's Contractor Procurement	8 wks	8
20	Permitting	4 wks	19
21	Contractor Mobilization	2 wks	20
22	Submittal Generation & Review	4 wks	21
23	Resubmittal Generation & Review (if needed)	4 wks	22
24	Material Procurement	16 wks	23
25	ETS Installation	16 wks	24
26	SAWS Metering Cabinet Installation	4 wks	25
27	Start-up & Testing	2 wks	26
28	Substantial Completion	0 wks	16,27



Project: SAWS Customer Conne
Date: Tue 2/24/26

Task	Project Summary	Manual Task	Start-only	Deadline			
Split	Inactive Task	Duration-only	Finish-only	Progress			
Milestone	Inactive Milestone	Manual Summary Rollup	External Tasks	Manual Progress			
Summary	Inactive Summary	Manual Summary	External Milestone				

A.1.5 Construction Checklist Template

SAWS DISTRICT COOLING SYSTEM
ETS CONSTRUCTION INSPECTION CHECKLIST

Customer: _____

Customer Address: _____

Contract Load (tons): _____

CHW Need Date: _____

POD/POR: _____

Inspection (circle one): **Substantial Completion** or **Final Completion**

SAWS DCS Inspector: _____ **Inspection Date:**_____

Email: _____ **Phone:**_____

Customer Representative:_____

Email: _____ **Phone:**_____

General Contractor: _____ **GC Rep:**_____

Email: _____ **Phone:**_____

Mechanical Contractor: _____ **MC Rep:**_____

Email: _____ **Phone:**_____

ETS ROOM

1.	ETS room is free of construction debris:	☐ Yes	☐ No
2.	Sufficient entrance to the ETS room:	☐ Yes	☐ No
	a. Door Type/Size: _____		
3.	Sufficient pathway exists for equipment maintenance and replacement:	☐ Yes	☐ No
4.	ETS room and equipment is on permanent power:	☐ Yes	☐ No
5.	Adequate lighting exists, not obstructed by equipment or piping:	☐ Yes	☐ No
	a. Measured footcandles at Control Panel: _____		
	b. Measured footcandles at Heat Exchanger: _____		
6.	Pipe penetrations are properly sealed and waterproofed:	☐ Yes	☐ No
7.	Floor drain in close proximity to the heat exchanger:	☐ Yes	☐ No
8.	Terminal unit installed to condition the ETS room.	☐ Yes	☐ No
	a. If CHW utilized, taps come from hot-side piping:	☐ Yes	☐ No
	b. Terminal unit is operational, with thermostat:	☐ Yes	☐ No
	c. Clean air filter and condensate drain installed:	☐ Yes	☐ No
9.	Hot-side piping has fill connection with backflow preventer:	☐ Yes	☐ No
10.	Water treatment present on cold-side piping:	☐ Yes	☐ No
11.	Hose bibb present in mechanical room:	☐ Yes	☐ No

Comments:

BOOSTER PUMP

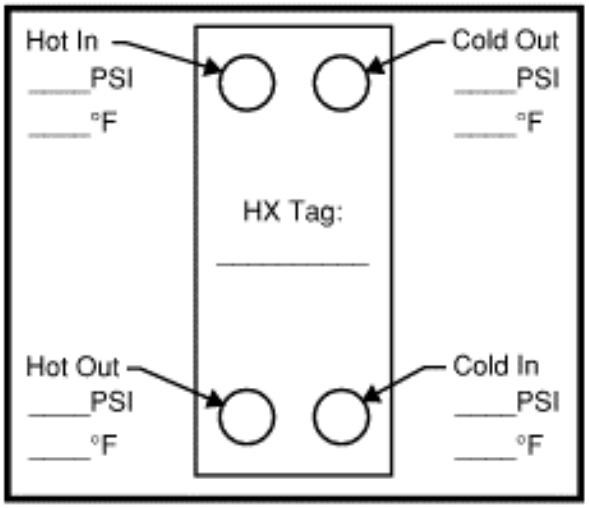
1. Pump nameplate present: ☐ Yes ☐ No
   a. Manufacturer: _____
   b. Model No.: _____
   c. Serial No: _____
   d. Capacity (GPM): _____
   e. Head (ft.): _____
   f. Impeller Dia. (in.): _____
   g. Speed (RPM): _____
2. Motor nameplate present: ☐ Yes ☐ No
   a. Manufacturer: _____
   b. HP: _____
   c. RPM: _____
3. Motor shaft grounding ring installed: ☐ Yes ☐ No
4. VFD nameplate present: ☐ Yes ☐ No
   a. Manufacturer: _____
   b. Model No.: _____
   c. Serial No.: _____
5. VFD provided with bypass: ☐ Yes ☐ No
6. Pump manufacturer's installation checklist complete: ☐ Yes ☐ No
7. Pump insulation installed: ☐ Yes ☐ No
8. Pump support method – Floor-supported:
   a. Suction and discharge supports present with neoprene pads: ☐ Yes ☐ No
9. Pump support method – Pipe-supported:
   a. Pump is "floating" freely in piping: ☐ Yes ☐ No
10. Sufficient overhead access exists for pump: ☐ Yes ☐ No
11. Sufficient removal path exists for pump: ☐ Yes ☐ No
12. Pump piping configuration matches CCS standards: ☐ Yes ☐ No
13. Pump Piping Accessories - Circle on table below.

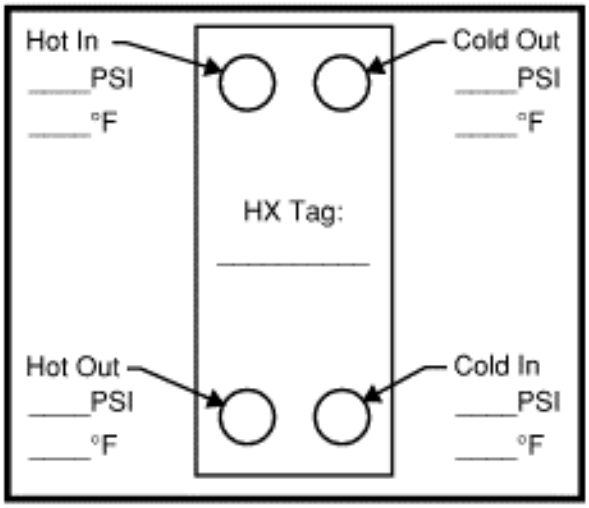
Pump Piping Accessories	Suction (CHWS)	Discharge (CHWS)
Isolation Valve	Yes No	Yes No
Expansion Joint	Yes No	Yes No
Strainer	Yes No	N/A
Check Valve	N/A	Yes No
Pressure Gauge	Yes No	Yes No
Pete's Plug	Yes No	Yes No
High Point Vent	N/A	Yes No
Low Point Drain Valve	N/A	Yes No

Comments:

HEAT EXCHANGER

1. HX nameplate present: ☐ Yes ☐ No
   a. Manufacturer: _____
   b. Model No.: _____
   c. Serial No: _____
2. HX insulated shroud installed: ☐ Yes ☐ No
3. HX installed on housekeeping pad with and base mounted to pad: ☐ Yes ☐ No
4. Sufficient access exists for heat exchanger: ☐ Yes ☐ No
   a. Clearance on service side: _____
   b. Clearance on opposite side: _____
5. HX piping configuration matches CCS standards: ☐ Yes ☐ No
   a. (Notate any deviations on diagram below.)





6. HX Piping Accessories - Circle on table below.

HX Piping Accessories	Cold - In (CHWS)	Cold - Out (CHWR)	Hot - In (BCHWR)	Hot - Out (BCHWS)
Isolation Valve	Yes No	Yes No	Yes No	Yes No
Relief Valve	N/A	Yes No	Yes No	N/A
Y-strainer	Yes No	N/A	Yes No	N/A
Thermometer	Yes No	Yes No	Yes No	Yes No
Pressure Gauge	Yes No	Yes No	Yes No	Yes No
Pete's Plug	Yes No	Yes No	Yes No	Yes No
Manual Air Vent	N/A	Yes No	Yes No	N/A
Drain Valve	Yes No	N/A	N/A	Yes No

Comments:

CHILLED WATER PIPING

1. No major routing deviations from shop drawings: ☐ Yes ☐ No
2. Piping is properly supported, with no weight transferred to HX's: ☐ Yes ☐ No
3. Flow meter installed with sufficient clearance: ☐ Yes ☐ No
    a. Flow Meter Size: _____
    b. Upstream Clearance: _____
    c. Downstream Clearance: _____
4. Flow meter can be removed without the need for temporary supports: ☐ Yes ☐ No
5. Control valves installed with sufficient clearance: ☐ Yes ☐ No
    a. CV #1 Size (in.): _____
    b. Upstream Clearance (in.): _____
    c. Downstream Clearance (in.): _____
    d. CV #2 Size (in.): _____
    e. Upstream Clearance (in.): _____
    f. Downstream Clearance (in.): _____
6. Control valves can be removed without the need for temporary supports: ☐ Yes ☐ No
7. Cold-side: Air vents installed at high point in piping system: ☐ Yes ☐ No
8. Hot-side: Air vents installed at high point in piping system: ☐ Yes ☐ No
9. Cold-side: Drains installed at low point in piping system: ☐ Yes ☐ No
10. Hot-side: Drains installed at low point in piping system: ☐ Yes ☐ No
11. Piping is completely insulated and jacketed per CCS standards: ☐ Yes ☐ No
12. Insulation shields are installed at all supports: ☐ Yes ☐ No
13. Isolation valves are operable without crushing insulation: ☐ Yes ☐ No
14. Valve tags installed: ☐ Yes ☐ No
15. Piping labeled with delineation between customer and SAWS piping, and direction of flow. ☐ Yes ☐ No

Comments:

INSTRUMENTATION & CONTROLS (Customer Responsibility)

Note: SAWS I&C will perform a separate inspection for their scope.

1. Dedicated 120V 20A circuit, terminated at a junction box above the control panel: ☐ Yes ☐ No
    a. Room/location of circuit breaker: _____
    b. Circuit No.: _____
2. Sufficient clearance provided for control panel (48" front, 12" all sides): ☐ Yes ☐ No

Comments:

CLOSEOUT DOCUMENTATION

The final version of the following items has been submitted to SAWS:

Test Results

1.	Hydrostatic pressure test results:	☐ Yes	☐ No
2.	Flushing/passivation test results:	☐ Yes	☐ No
3.	Welding inspection reports:	☐ Yes	☐ No

Documentation

1.	As-built drawings (including 3D isometric views):	☐ Yes	☐ No
2.	3D model (Revit, AutoCAD 3D, Navisworks):	☐ Yes	☐ No
3.	O&M Manuals:	☐ Yes	☐ No

Other

1.	Finalized Easement Agreement:	☐ Yes	☐ No
2.	Finalized Service Agreement:	☐ Yes	☐ No
3.	Key or access card for building access & ETS room provided to SAWS:	☐ Yes	☐ No

SIGNOFF

SAWS DCS Inspector: _____ Date:_____

Customer Representative: _____ Date:_____

General Contractor: _____ Date:_____

Mechanical Contractor: _____ Date:_____

Comments:

A.1.6 Building Design Best Practices (Delta T)

DELTA T BUILDING DESIGN BEST PRACTICE

Customer will use commercially reasonable efforts, including, without limitation, implementing the following Best Practices, to achieve the Design Return Temperature. Customer is recommended to monitor and take corrective action to achieve this design temperature.

1. Select cooling coils for an entering chilled water temperature 1°F or more above the Design Supply Temperature, and for a return temperature 2°F or more above the Design Return Temperature (for example: Heat Exchanger selection design is 44°F/59°F, size the coils for 45°F/61°F). Monitor return temperature and take corrective action if it falls below the Design Return Temperature.
2. Specify properly sized pressure independent control valves (**two-way**) to optimize stability and cooling coil performance so that a high delta T (Design Return Temperature and higher) can be achieved for the building and plant. ***Three-way valves and bypasses*** will lower the return water temperature and a 6% per degree penalty is charged to the customer for each degree below the required return temperature. This penalty is based on the total monthly billing of the Commodity Charge.
3. Control valves should be a high-quality valve capable of control and positive shut-off under the highest expected pressures.
4. Omit external balancing devices.
5. Use run-around pre-cooling/preheating coils for make-up air.
6. In existing buildings, **replace three-way bypass control valves** with two-way control valves and **eliminate bypasses**.
7. Close control valves when air handling unit fans are off.
8. Reduce chilled water flow at partial load by use of variable frequency drives “VFD’s” or other means as approved by SAWS.
9. Eliminate constant speed chilled water “booster” pumps.
10. Specify actuators capable of positioning the valve at low flow conditions.
11. Provide scheduled maintenance of water treatment services to protect and optimize piping, coils, and Heat Exchangers on the Customer’s side of the Heat Exchanger(s).
12. All of Customer’s chilled water piping shall be flushed and passivated by a water treatment professional prior to commissioning.
13. Specify DDC control to achieve precise valve positioning.
14. Treat sensible cooling and cooling/dehumidifying separately.
15. Use two cooling coils in series, single pass. (Optional)
16. Calibrate and protect temperature and humidity sensors.
17. Minimize waterside fouling and airside restrictions.
18. Elevate chilled water supply temperatures at partial cooling loads.
19. Replace marginally performing cooling coils.

Reference:
“District Cooling Best Practice Guide (2008 First Edition),” International District Energy Association, www.districtenergy.org.

A.2 Energy Transfer Station Details

A.2.1 Energy Transfer Station Schematic

A.2.2 Heat Exchanger Piping Connection Detail

A.2.3 Heat Exchanger Clearances

A.2.4 Automatic Air Vent Detail

A.2.5 Manual Air Vent Detail

A.2.6 Low Point Drain Detail

A.2.7 Pressure Transmitter Detail

A.2.8 Thermowell Detail

A.2.9 Temperature Transmitter Detail

A.2.10 Test Port Detail

A.2.11 Pressure Gauge Detail

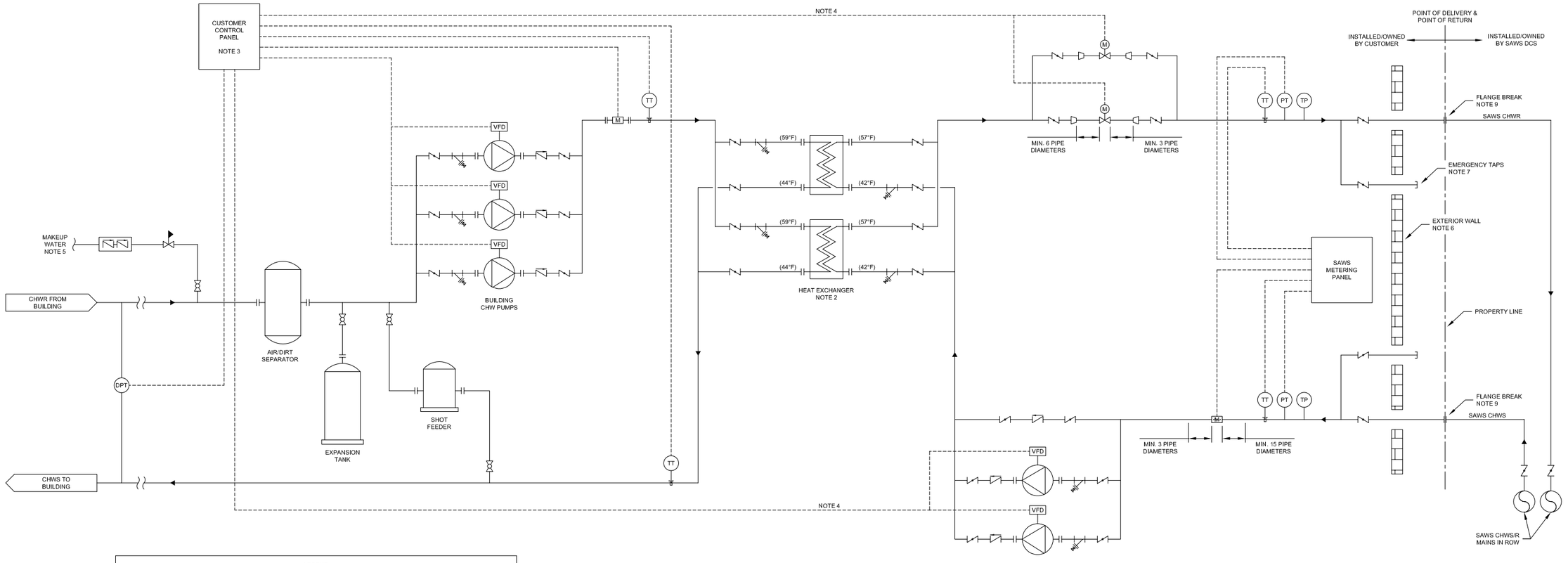
A.2.12 Ultrasonic Flow Meter Detail

A.2.13 Conduit Terminal at Instrument Detail

A.2.14 Control Panel Detail

A.2.15 Booster Pump Detail

NOTES:
1. THIS DRAWING IS SCHEMATIC IN NATURE, AND IS NOT REPRESENTATIVE OF THE PHYSICAL PIPING LAYOUT.
2. REFER TO DETAIL M2 FOR TYPICAL HEAT EXCHANGER PIPING CONNECTION DETAIL.
3. CUSTOMER SIDE PIPING, EQUIPMENT, CONTROLS, AND WATER TREATMENT IS THE RESPONSIBILITY OF THE CUSTOMER. EXAMPLE CONFIGURATION SHOWN IS FOR REFERENCE ONLY.
4. BOOSTER PUMP AND CONTROL VALVES CONTROLLED BY CUSTOMER.
5. CUSTOMER PROVIDED MAKEUP WATER CONNECTION WITH CODE REQUIRED BACKFLOW PREVENTION.
6. CUSTOMER RESPONSIBLE FOR SLEEVE AND WATERPROOFING EXTERIOR PIPING PENETRATION.
7. OPTIONAL: EXTERIOR TAPS FOR EMERGENCY CHILLER CONNECTION.
8. INSTALL AUTOMATIC AIR VENTS AT HIGH POINTS IN PIPING.
9. SAWS/CUSTOMER PIPING INTERFACE.



LEGEND					
	BUTTERFLY VALVE		PRESSURE REDUCING VALVE		PIPE REDUCER
	BALL VALVE		STRAINER W/ BLOWDOWN VALVE	TT	TEMPERATURE TRANSMITTER W/ THERMOWELL
	CHECK VALVE	M	CONTROL VALVE	TP	TEST PORT (PETE'S PLUG)
M	FLOW METER		BACKFLOW PREVENTER	PT	PRESSURE TRANSMITTER
M	ULTRASONIC FLOW METER				

M1 ENERGY TRANSFER STATION SCHEMATIC

N.T.S

SAWS DCS CUSTOMER CONNECTION STANDARDS

SAN ANTONIO WATER SYSTEM
SAWS DCS CUSTOMER CONNECTION STANDARDS
SAWS JOB NO. 23-7507

SAWS DCS CUSTOMER CONNECTION STANDARDS

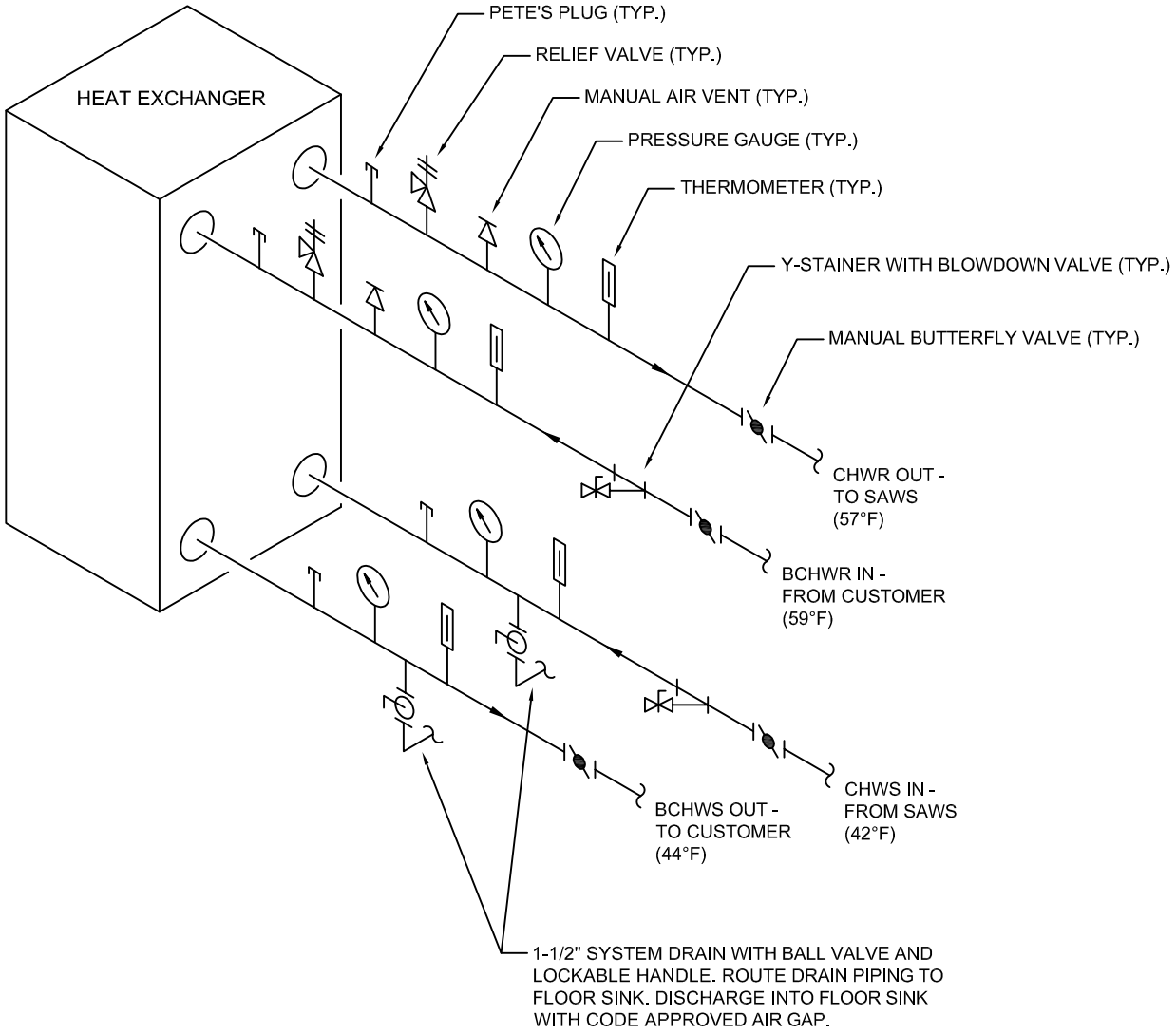
REVISIONS

NO	DATE	DESCRIPTION
0	05/10/2024	SAWS DCS - CCS
1	10/23/2025	SAWS DCS - CCS

TITLE:
ENERGY TRANSFER STATION SCHEMATIC

PROJ #: W-XXXXX-XXX
DRAWN BY: B.M
CHECKED BY: JPS
DATE: 05/10/2025

SHEET:
M1



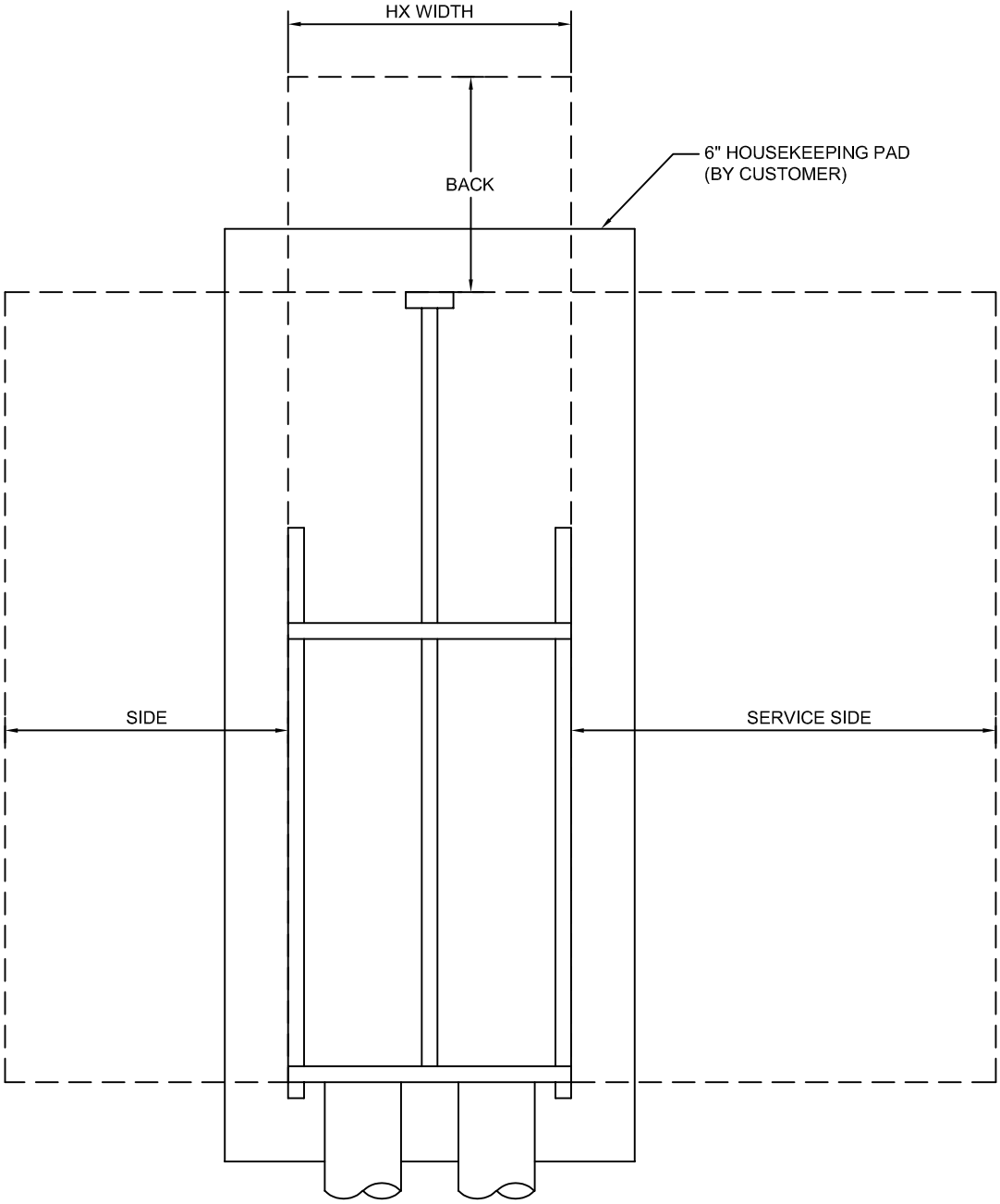
NOTES:

1. SUGGESTED TEMPERATURES SHOWN FOR CLARITY.

M2 HEAT EXCHANGER PIPING CONNECTION DETAIL

N.T.S

SAN ANTONIO WATER SYSTEM SAWS DCS CUSTOMER CONNECTION STANDARDS SAWS JOB NO. 23-7507		REVISIONS NO | DATE | DESCRIPTION 0 | 05/10/2024 | SAWS DCS - CCS 1 | 10/23/2026 | SAWS DCS - CCS	PROJ.: WJXX/5901 DRAWN BY: DJM CHECKED BY: JPS DATE: 05/10/2024	TITLE: HEAT EXCHANGER PIPING CONNECTION DETAIL	SHEET: M2



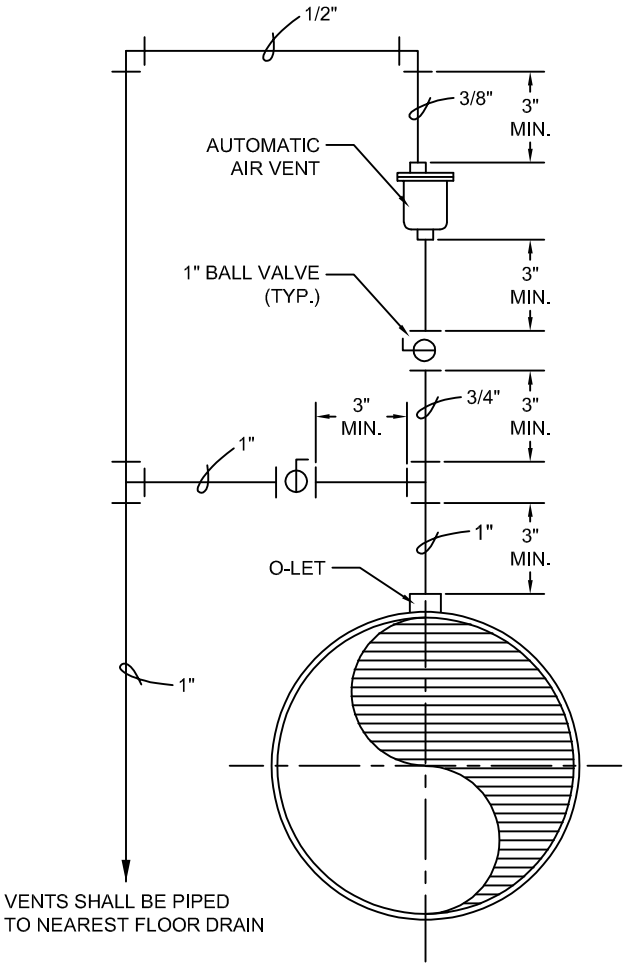
NOTES:

1. MINIMUM CLEARANCES:
   'SERVICE SIDE' CLEARANCE: HX WIDTH PLUS 12"
   'SIDE' CLEARANCE: HX WIDTH OR 24", WHICHEVER IS GREATER
   'BACK' CLEARANCE: 36"
   'TOP' CLEARANCE: 24" (NOT SHOWN)
2. CLEARANCE SPACE SHALL BE FREE AND CLEAR OF ALL OBSTRUCTIONS.
3. FOR MULTIPLE HX INSTALLATION, THE SERVICE SIDE CLEARANCE CAN BE SHARED.
4. HEAT EXCHANGER SHALL BE INSTALLED ON A 6" HOUSEKEEPING PAD. THE PAD SHALL EXTEND 6" BEYOND THE HX FOOTPRINT IN ALL DIRECTIONS.

M3 HEAT EXCHANGER CLEARANCES (PLAN VIEW)

N.T.S

SAN ANTONIO WATER SYSTEM SAWS DCS CUSTOMER CONNECTION STANDARDS SAWS JOB NO. 23-7507		REVISIONS NO. DATE DESCRIPTION 0 05/10/2024 SAWS DCS - CCS	PROJ.: WJXX/5901 DRAWN BY: DJM CHECKED BY: JPS DATE: 05/10/2024	TITLE: HEAT EXCHANGER CLEARANCES DETAIL	SHEET: M3



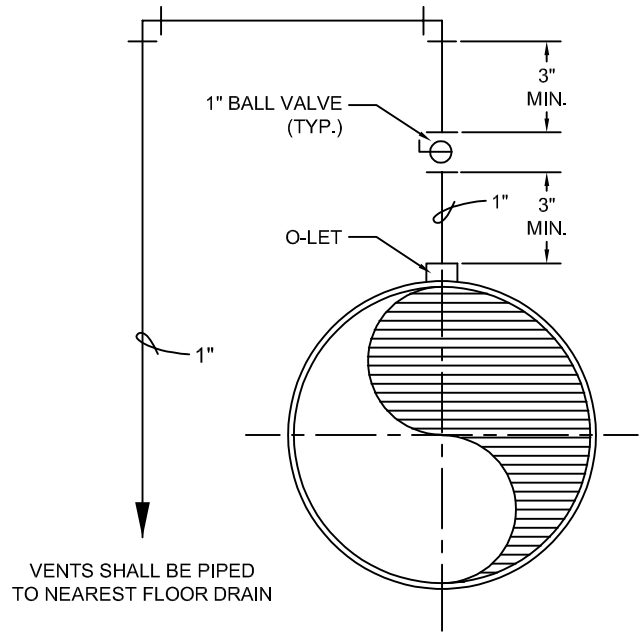
NOTES:

1. PROVIDE AUTOMATIC AIR VENTS AT THE HIGHEST POINT OF THE PIPING SYSTEM AND OTHER LOCATIONS WHERE SHOWN AND WHERE CHANGES IN DIRECTION REQUIRES VENTING OF AIR.

M4 **AUTOMATIC AIR VENT DETAIL**

N.T.S

SAN ANTONIO WATER SYSTEM SAWS DCS CUSTOMER CONNECTION STANDARDS SAWS JOB NO. 23-7507		REVISIONS NO. 0 DATE 05/10/2024 DESCRIPTION SAWS DCS - CCS	PROJ.: WJXX/5901 DRAWN BY: DJM CHECKED BY: JPS DATE: 05/10/2024	TITLE: AUTOMATIC AIR VENT DETAIL	SHEET: M4



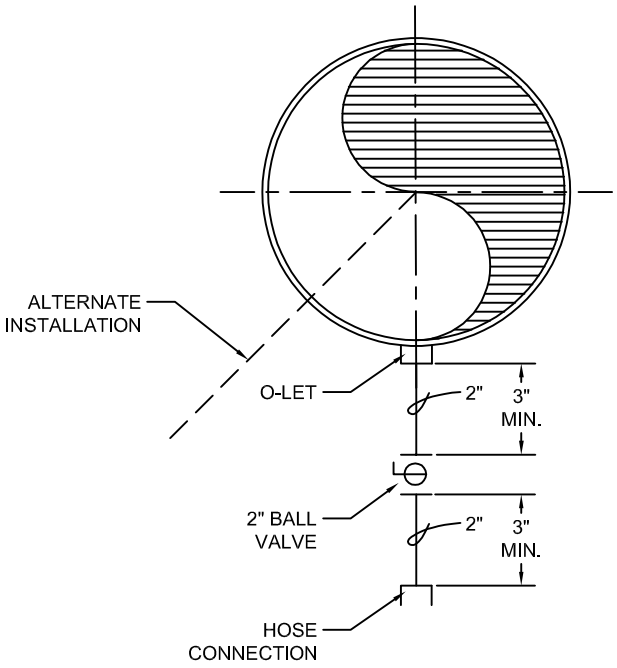
NOTES:

1. PROVIDE AIR VENTS AT THE HIGH POINTS OF THE PIPING SYSTEM, AT HEAT TRANSFER EQUIPMENT, AND OTHER LOCATIONS WHERE SHOWN AND WHERE CHANGES IN DIRECTION REQUIRES VENTING OF AIR.

M5 MANUAL AIR VENT DETAIL

N.T.S

SAN ANTONIO WATER SYSTEM SAWS DCS CUSTOMER CONNECTION STANDARDS SAWS JOB NO. 23-7507		REVISIONS NO | DATE | DESCRIPTION 0 | 05/10/2024 | SAWS DCS - CCS	PROJ.: WJXN/5901 DRAWN BY: DJM CHECKED BY: JPS DATE: 05/10/2024	TITLE: MANUAL AIR VENT DETAIL	SHEET: M5



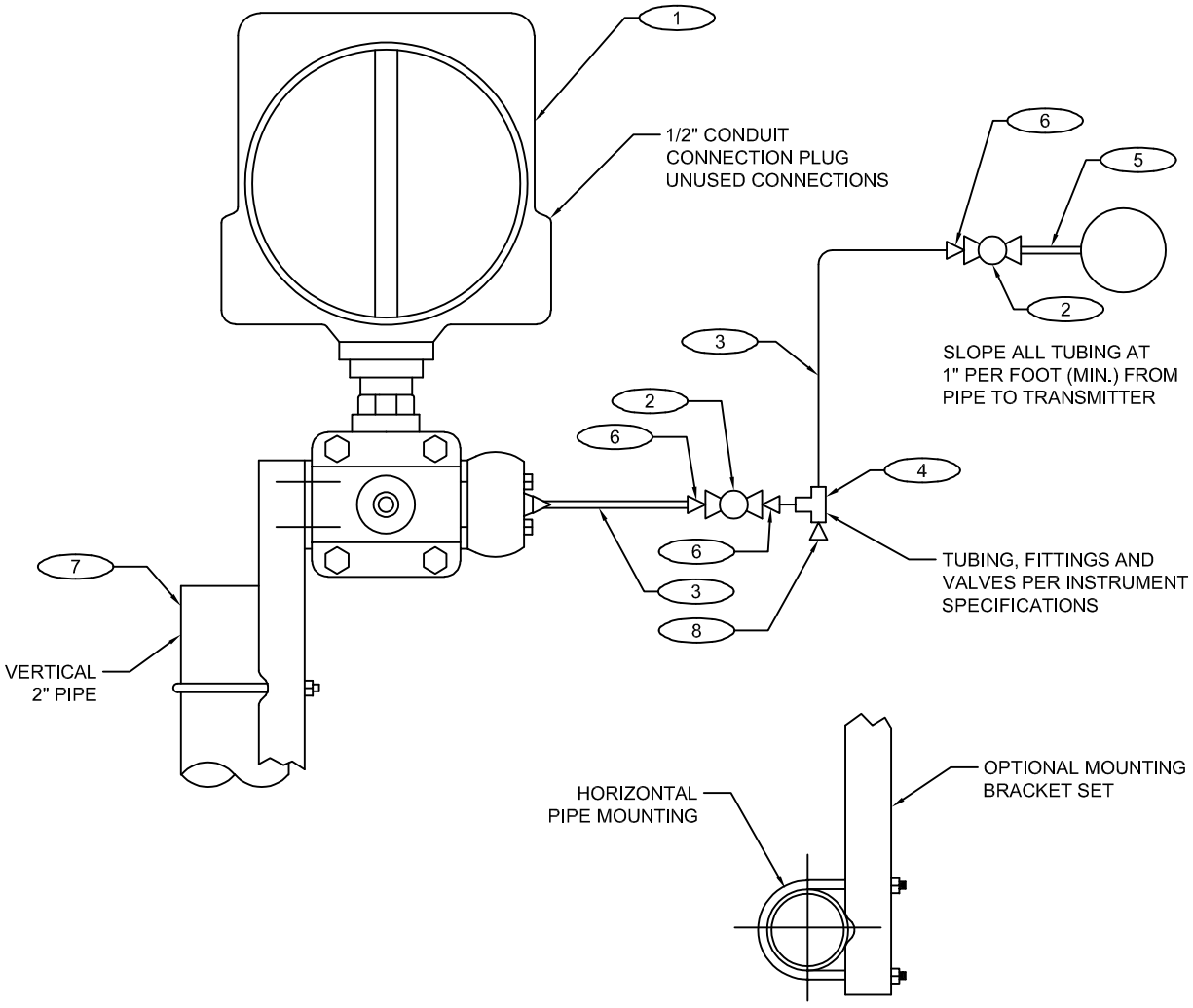
NOTES:

1. PROVIDE DRAIN AT THE LOW POINTS OF THE PIPING SYSTEM AND OTHER LOCATIONS WHERE SHOWN.
2. PROVIDE HOSE CONNECTION.
3. ALTERNATE: IF VERTICAL CLEARANCE IS NOT AVAILABLE TO INSTALL DRAIN ASSEMBLY IN THE VERTICAL ORIENTATION, THE DRAIN ASSEMBLY MAY BE INSTALLED AT A 45 DEGREE ANGLE FROM VERTICAL.

M6 LOW POINT DRAIN DETAIL

N.T.S

SAN ANTONIO WATER SYSTEM SAWS DCS CUSTOMER CONNECTION STANDARDS SAWS JOB NO. 23-7507		REVISIONS NO | DATE | DESCRIPTION 0 | 05/10/2024 | SAWS DCS - CCS	PROJ.: WJXN/5901 DRAWN BY: DJM CHECKED BY: JPS DATE: 05/10/2024	TITLE: LOW POINT DRAIN DETAIL	SHEET: M6



LIST OF MATERIALS		
ITEM	QTY	DESCRIPTION
1	1	TRANSMITTER WITH 2 VALVE MANIFOLD
2	2	1/2" NPT BALL VALVE 316 SS
3	AR	1/2" OD TUBING 316 SS
4	1	1/2" OD TUBING TEE 316 SS
5	1	1/2" PIPE NIPPLE (1/2" X 3") 316 SS
6	4	1/2"T X 1/2" MALE TUBING CONNECTOR 316 SS
7	1	2" PIPE STAND STEEL
8	1	1/2" OD TUBING PLUG 316 SS

M7 PRESSURE TRANSMITTER DETAIL

N.T.S

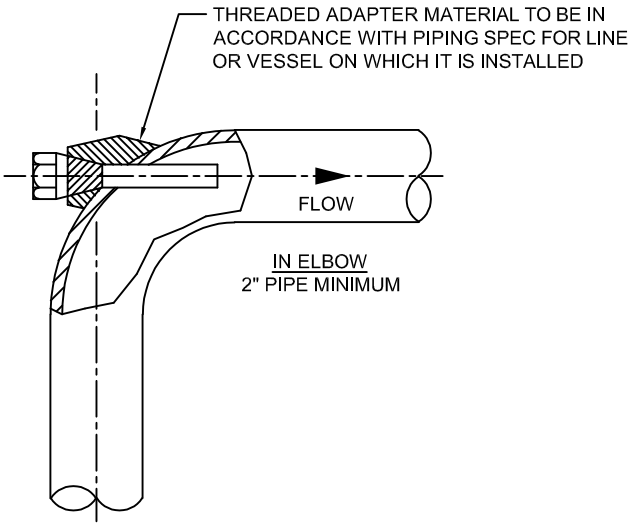
SAN ANTONIO WATER SYSTEM
SAWS DCS CUSTOMER
CONNECTION STANDARDS
SAWS JOB NO. 23-7507

REVISIONS		
NO	DATE	DESCRIPTION
0	05/10/2024	SAWS DCS - CCS

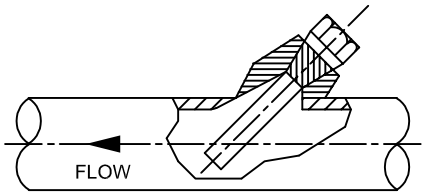
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DRAWN BY: DJM
CHECKED BY: JPS
DATE: 05/10/2024

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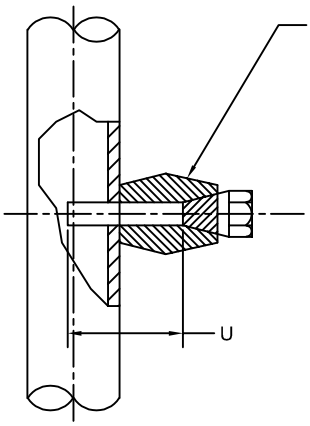
SHEET: M7



IN ELBOW
2" PIPE MINIMUM



IN HORIZONTAL
OR VERTICAL
4" PIPE MINIMUM



IN VERTICAL OR
HORIZONTAL
6" PIPE MINIMUM

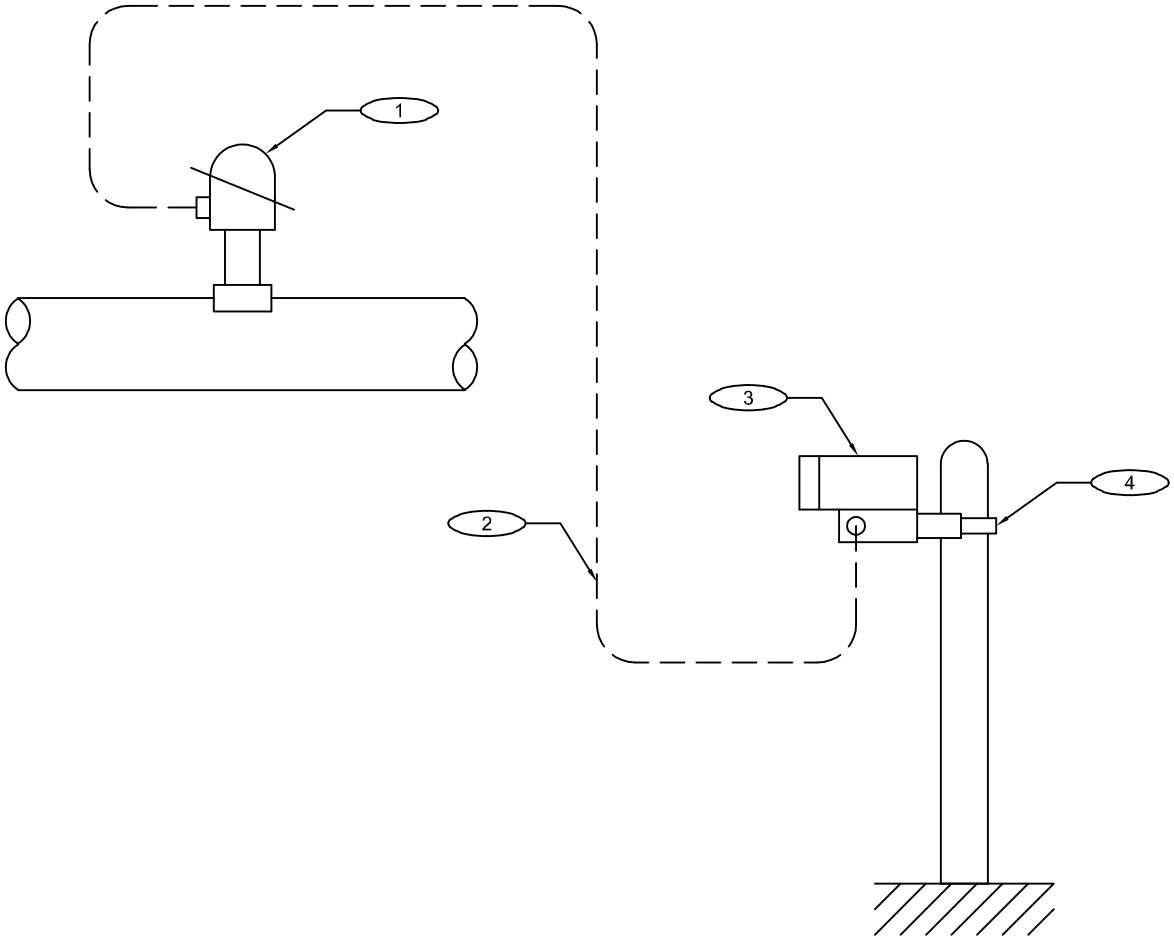
NOTES:

1. FOR INSTALLATION IN PIPE SIZES BELOW MINIMUM SHOWN, INCREASE PIPE TO MINIMUM LOCALLY OR INSTALL IN ELBOW OR TEE.
2. SADDLE TYPE WELDING FITTINGS ON VESSELS SHALL MEET PIPE OR VESSEL SPECIFICATIONS.
3. PLUG TO BE INSERTED IN ADAPTER TO PREVENT DISTORTION WHEN WELDING.
4. CHECK THERMOWELL LENGTH BEFORE LOCATING.
5. FOR PIPE SMALLER THAN 2" ADD REDUCERS TO KEEP 2" PIPE IN ELBOW CONNECTION.

U DIMENSION			
INSTALLATION	PIPE SIZE	U DIMENSION	NOTES
IN ELBOW	2" & SMALLER	4 1/2"	SWAG UP TO 2"
	3'-6"	7 1/2"	
	>6"	10 1/2"	
PERPENDICULAR INTO PIPE	<6"	-	INSTALL IN ELBOW
	6"	4 1/2"	PREFERRED INSTALLATION IS IN ELBOW DUE TO VELOCITY CONSIDERATIONS
	8"	4 1/2"	
	10"-12"	7 1/2"	
	>12"	10 1/2"	

M8 THERMOWELL DETAIL

N.T.S

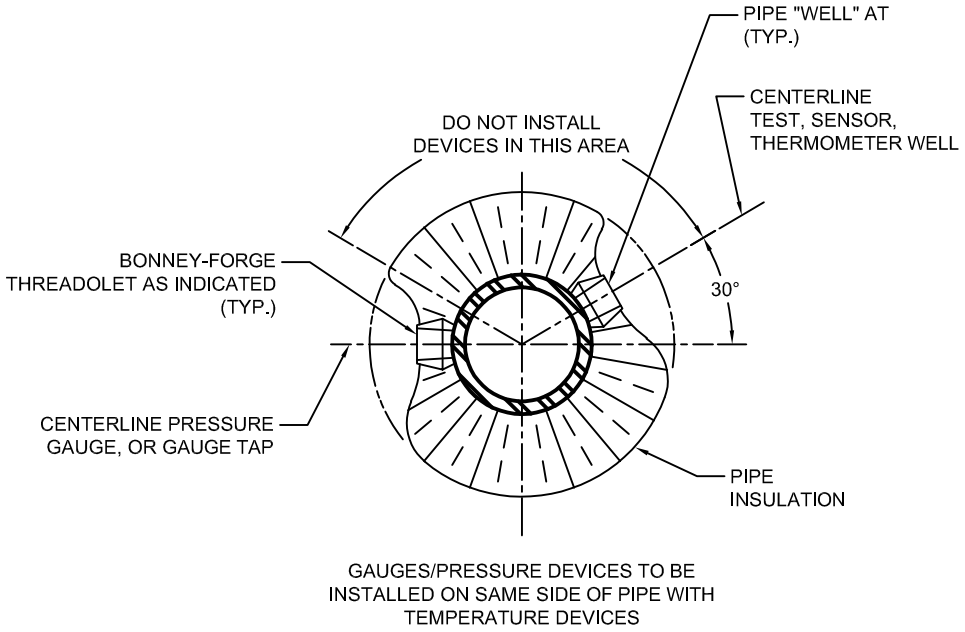


LIST OF MATERIALS		
ITEM	QTY	DESCRIPTION
1	1	TW/TE ASSEMBLY
2	A/R	ELECTRIC CABLE
3	1	TEMPERATURE TRANSMITTER ASSEMBLY
4	1	MOUNTING BRACKET

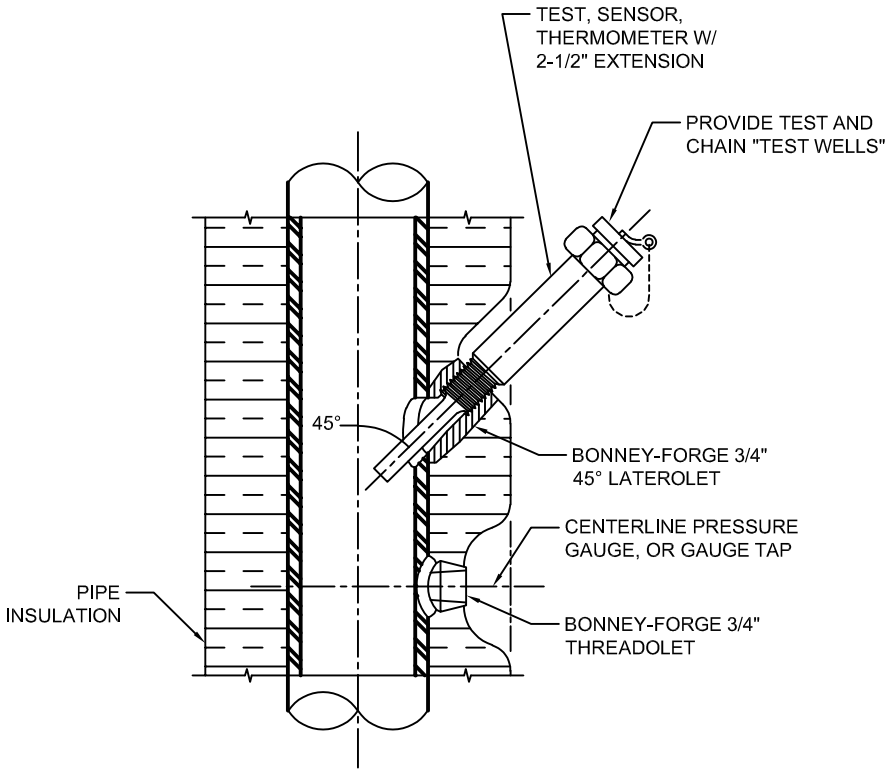
M9 TEMPERATURE TRANSMITTER (REMOTE MOUNTED) DETAIL

N.T.S

SAN ANTONIO WATER SYSTEM SAWS DCS CUSTOMER CONNECTION STANDARDS SAWS JOB NO. 23-7507		REVISIONS NO | DATE | DESCRIPTION 0 | 05/10/2024 | SAWS DCS - CCS	PROJ.: WJXX/5901 DRAWN BY: DJM CHECKED BY: JPS DATE: 05/10/2024	TITLE: TEMPERATURE TRANSMITTER DETAIL	SHEET: M9



HORIZONTAL PIPE



VERTICAL PIPE

M10 TEST PORT DETAIL

N.T.S

SAN ANTONIO WATER SYSTEM SAWS DCS CUSTOMER CONNECTION STANDARDS SAWS JOB NO. 23-7507		REVISIONS NO | DATE | DESCRIPTION 0 | 05/10/2024 | SAWS DCS - CCS	PROJ.: WJXN/5901 DRAWN BY: DJM CHECKED BY: JPS DATE: 05/10/2024	TITLE: TEST PORTAL DETAIL	SHEET: M10

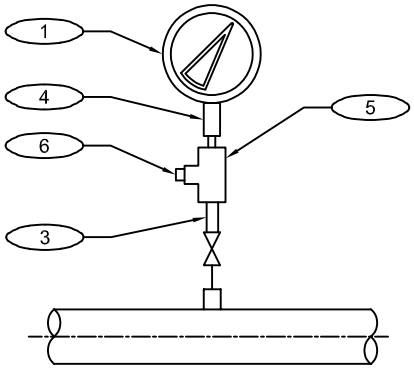


FIGURE A
DIRECT MOUNTED

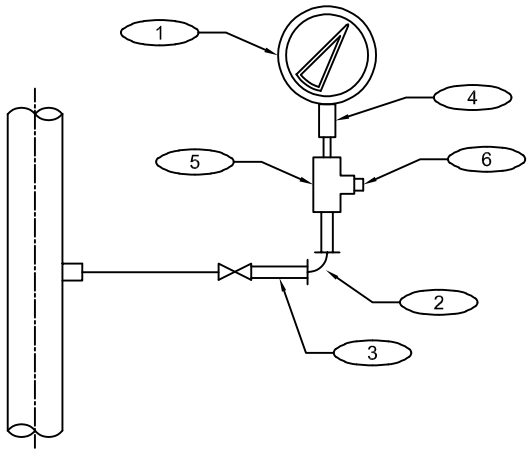


FIGURE B
DIRECT MOUNTED

NOTES:

1. PIPE, FITTINGS & TUBING SHALL CONFORM WITH MECHANICAL STANDARDS FOR SERVICE CONDITIONS SPECIFIED.
2. CONNECTING TUBING SHALL BE SUPPORTED ON BRACKETS OR HANGERS RIGIDLY FASTENED TO WALLS OR STRUCTURAL MEMBERS.
3. USE 316 SS MATERIALS UNLESS OTHERWISE NOTED. MATERIAL SHALL CONFORM TO THOSE SPECIFIED IN THE APPROPRIATE AND PIPING CLASSIFICATION STANDARDS.
4. INSULATION & MATERIAL SHALL MEET THE REQUIREMENTS OF THE SPECIFICATION.

LIST OF MATERIALS		
ITEM	QTY	DESCRIPTION
1	1	PRESSURE GAUGE
2	2	1/2" FEMALE ELBOW
3	A/R	1/2" SHORT NIPPLE
4	A/R	1/2" COUPLING OR 1/2" NPT x 1/4" NPT REDUCER
5	A/R	1/2" FEMALE TEE
6	A/R	1/2" PIPE PLUG

M11 PRESSURE GAUGE DETAIL

N.T.S

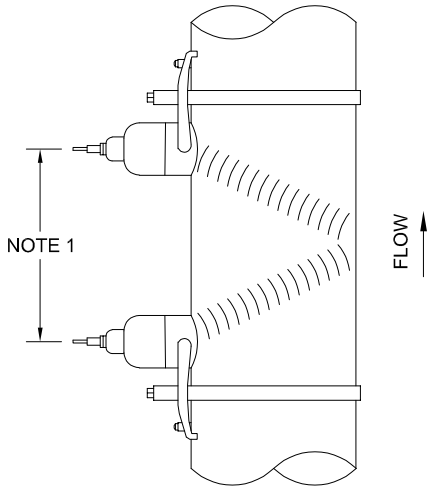
SAN ANTONIO WATER SYSTEM
SAWS DCS CUSTOMER
CONNECTION STANDARDS
SAWS JOB NO. 23-7507

REVISIONS		
NO	DATE	DESCRIPTION
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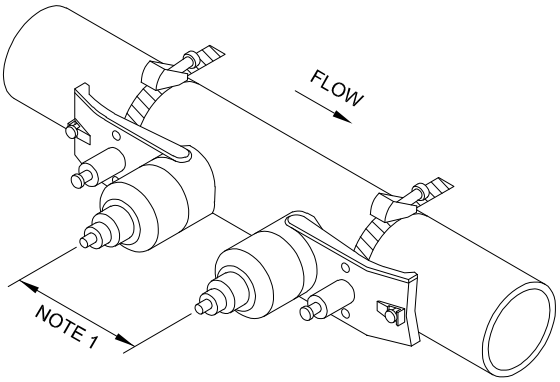
PROJ.: WJXX/5901
DRAWN BY: DJM
CHECKED BY: JPS
DATE: 05/10/2024

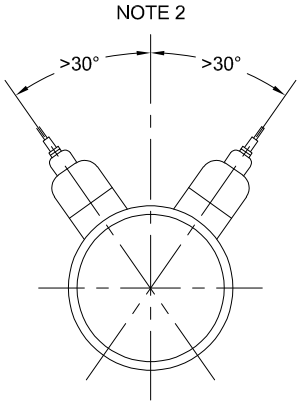
TITLE: PRESSURE GAUGE DETAIL

SHEET: M11



VERTICAL MOUNTING





HORIZONTAL MOUNTING

NOTES:

1. REFER TO MANUFACTURER'S INSTALLATION MANUAL FOR REQUIRED TRANSDUCER SPACING.
2. FOR HORIZONTAL PIPING, TRANSDUCERS TO BE INSTALLED ON SIDES OF PIPE, NOT TOP OR BOTTOM.
3. NEVER INSTALL THE FLOW METER IN THE HIGH POINT OF THE PIPING SYSTEM.
4. IF FLOW METER IS TO BE INSTALLED IN A VERTICAL PIPE, FLUID SHALL FLOW UP INTO TUBE TO MAINTAIN A FLOODED STATE.
5. INSTALL FLOW METER WITH A MINIMUM OF 15 STRAIGHT PIPE DIAMETERS UPSTREAM AND 3 STRAIGHT PIPE DIAMETERS DOWNSTREAM TO ANY OBSTRUCTIONS OR CHANGES IN FLOW DIRECTION. DIAMETERS SHALL BE EQUAL TO THE PIPE'S NOMINAL DIAMETER.
6. TRANSMITTER TO BE REMOTELY MOUNTED IN SAWS METERING CABINET.

M12 ULTRASONIC FLOW METER DETAIL

N.T.S

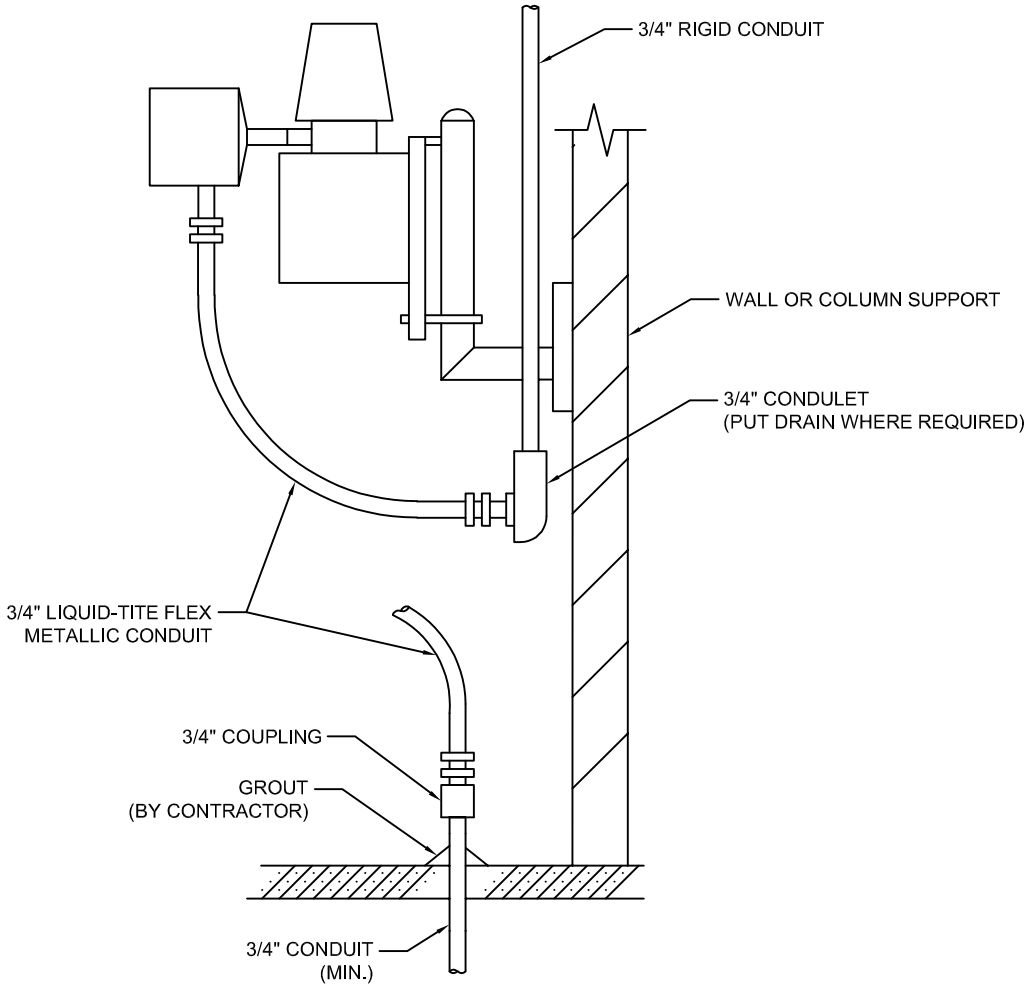
SAN ANTONIO WATER SYSTEM
SAWS DCS CUSTOMER
CONNECTION STANDARDS
SAWS JOB NO. 23-7507

REVISIONS		
NO	DATE	DESCRIPTION
0	05/10/2024	SAWS DCS - CCS
1	10/23/2026	SAWS DCS - CCS

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DRAWN BY: DJM
CHECKED BY: JPS
DATE: 05/10/2024

TITLE: ULTRASONIC FLOW METER DETAIL

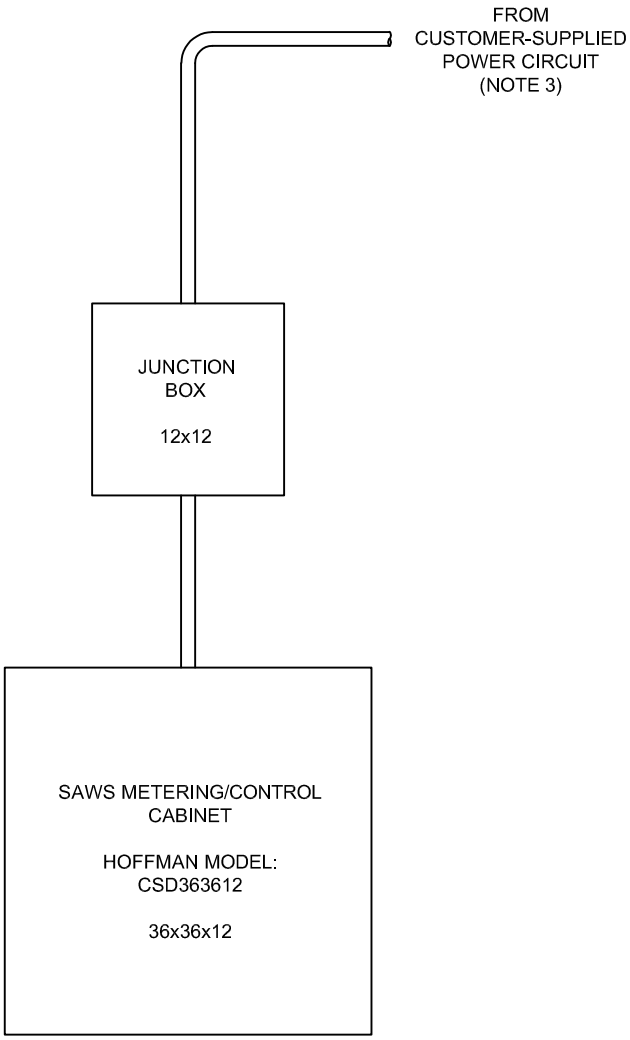
SHEET: M12



M13 CONDUIT TERMINATION AT INSTRUMENT DETAIL

N.T.S

SAN ANTONIO WATER SYSTEM SAWS DCS CUSTOMER CONNECTION STANDARDS SAWS JOB NO. 23-7507		REVISIONS NO | DATE | DESCRIPTION 0 | 05/10/2024 | SAWS DCS - CCS	PROJ.: WJXX/5901 DRAWN BY: DJM CHECKED BY: JPS DATE: 05/10/2024	TITLE: CONDUIT TERMINATION AT INSTRUMENT DETAIL	SHEET: M13



NOTES:

1. PROVIDE A MINIMUM OF 48" FRONT CLEARANCE AND MINIMUM OF 12" CLEARANCE AROUND ALL SIDES OF PANEL.
2. SUPPORT PANEL FROM VERTICAL UNI-STRUT CONNECTED TO THE WALL.
3. CUSTOMER SHALL PROVIDE A DEDICATED 120V, 20A CIRCUIT IN A CONTINUOUS 1.5" EMT CONDUIT, TERMINATED IN A 12x12 JUNCTION BOX TO SAWS CONTROL CABINET.

M14 **CONTROL PANEL DETAIL**

N.T.S

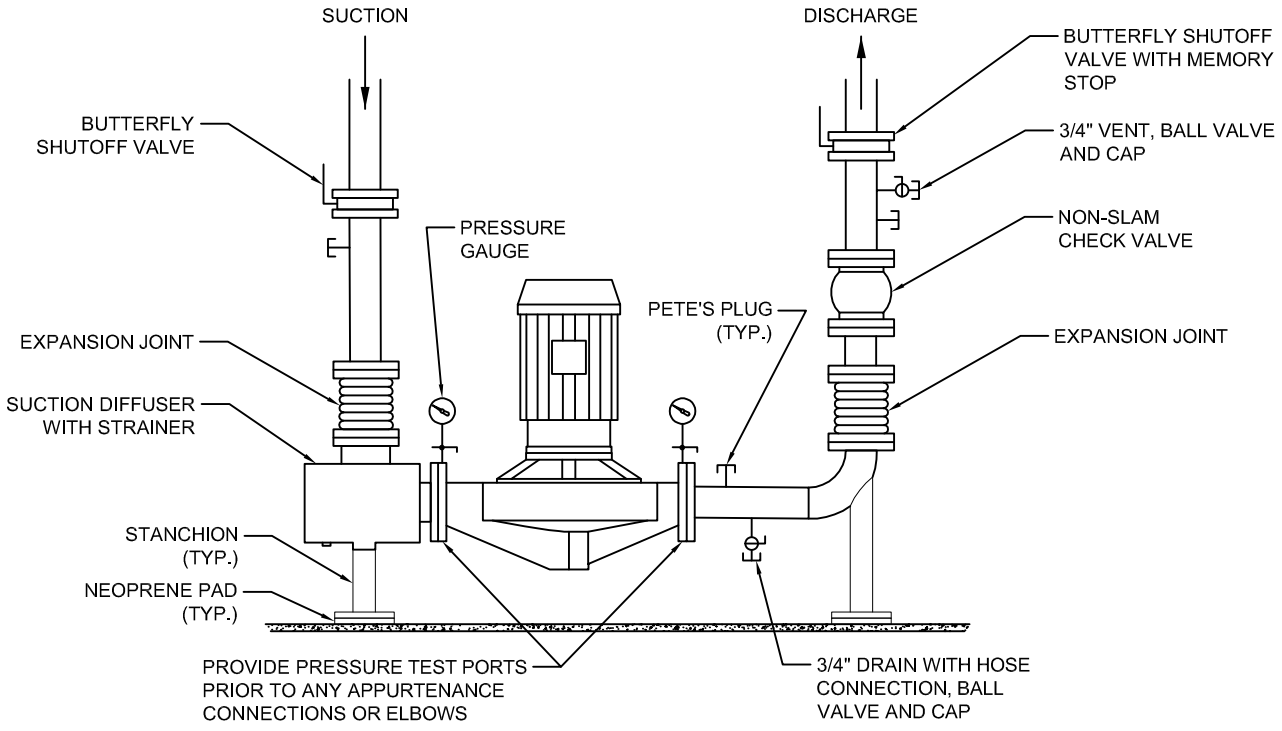
SAN ANTONIO WATER SYSTEM
SAWS DCS CUSTOMER
CONNECTION STANDARDS
SAWS JOB NO. 23-7507

REVISIONS		
NO	DATE	DESCRIPTION
0	05/10/2024	SAWS DCS - CCS

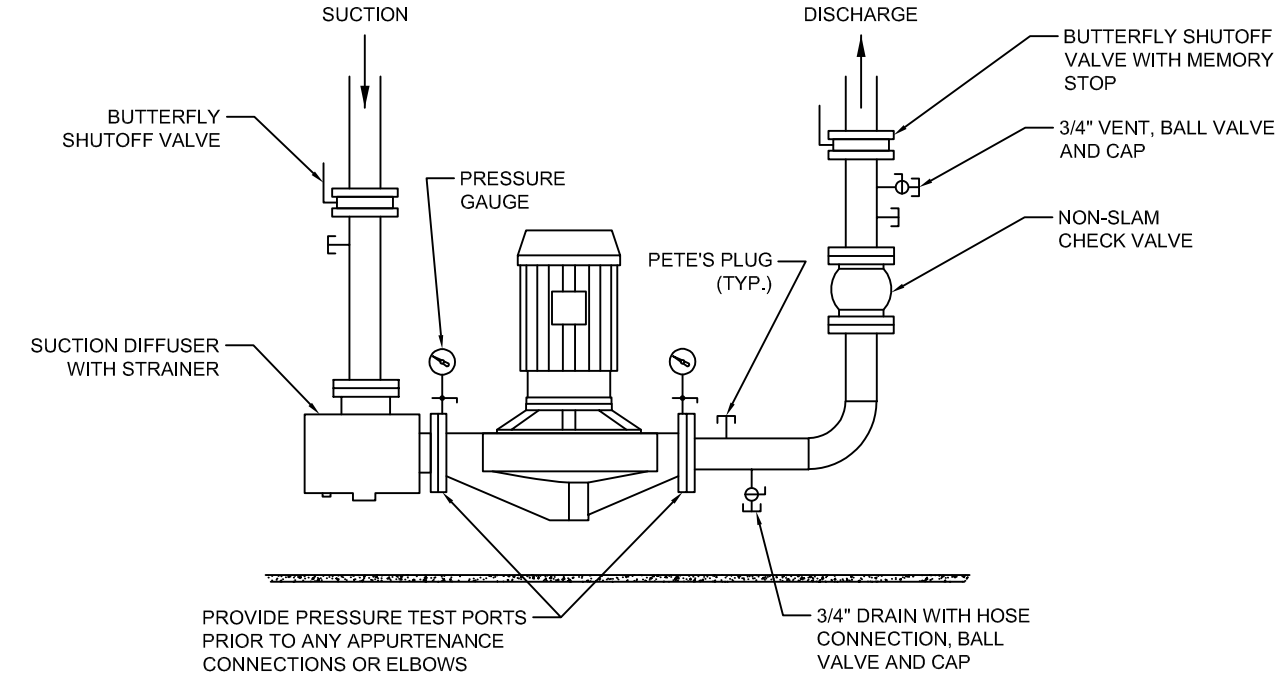
PROJ.: WJXX/5901
DRAWN BY: DJM
CHECKED BY: JPS
DATE: 05/10/2024

TITLE: CONTROL PANEL DETAIL

SHEET: M14



FLOOR SUPPORTED



PIPE SUPPORTED

NOTES:

1. TWO POSSIBLE INSTALLATION METHODS SHOWN FOR REFERENCE.
   INSTALL INLINE PUMP IN COMPLIANCE WITH PUMP MANUFACTURER'S RECOMMENDATIONS.

M15 BOOSTER PUMP DETAIL

N.T.S

SAN ANTONIO WATER SYSTEM SAWS DCS CUSTOMER CONNECTION STANDARDS SAWS JOB NO. 23-7507		REVISIONS NO. DATE DESCRIPTION 0 10/23/2026 SAWS DCS - CCS	PROJ.: WJXX/5901 DRAWN BY: DJM CHECKED BY: JPS DATE: 10/23/2026	TITLE: BOOSTER PUMP DETAIL	SHEET: M15

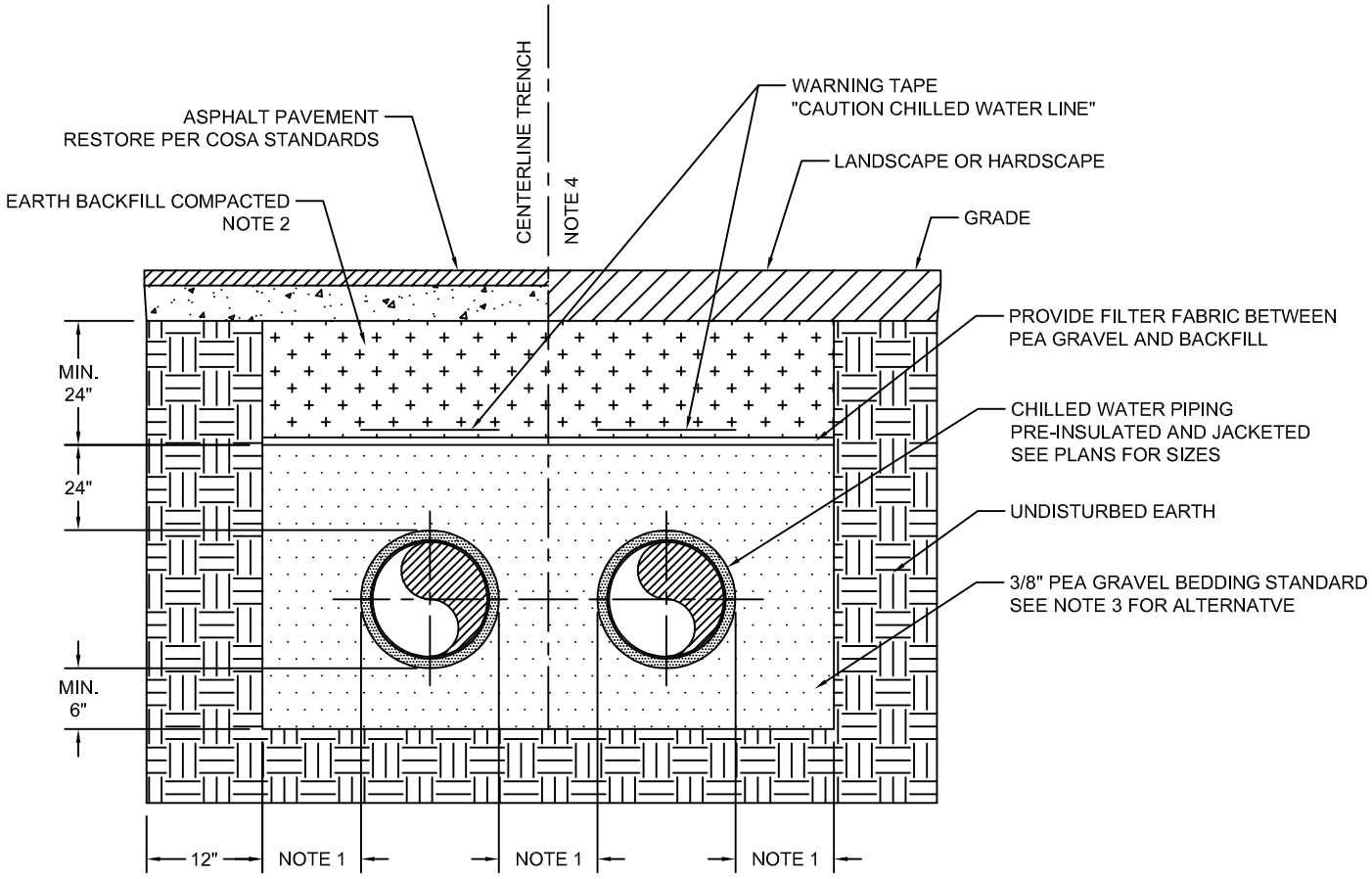
A.3 Underground Chilled Water Piping Details

A.3.1 Chilled Water Trench Detail

A.3.2 Direct-Buried Butterfly Detail

A.3.3 Air Release Valve Assembly Detail

A.3.4 Circulation Loop Detail



NOTES:

1. PROVIDE THE GREATER OF 18" OR 1-1/2" PIPE DIAMETERS OF SEPARATION TO OTHER UTILITIES OR TRENCH EDGE.
2. COMPACT BACKFILL MATERIAL IN 6-INCH LIFTS TO A DENSITY OF AT LEAST 95 PERCENT OF THE MODIFIED PROCTOR MAXIMUM DRY DENSITY (ASTM D 1557).
3. CLSM (FLOWABLE FILL) SHALL BE ACCEPTABLE IN LONG RUNS OF PIPE WHERE NO VALVES, AIR RELEASES OR VAULTS ARE LOCATED. SAWS APPROVAL IS REQUIRED FOR THIS ALTERNATIVE.
4. THIS DETAIL IS APPLICABLE FOR BOTH ASPHALT AND LANDSCAPE/HARDSCAPE FINISH GRADE CONDITIONS.

C1

CHILLED WATER TRENCH DETAIL

N.T.S

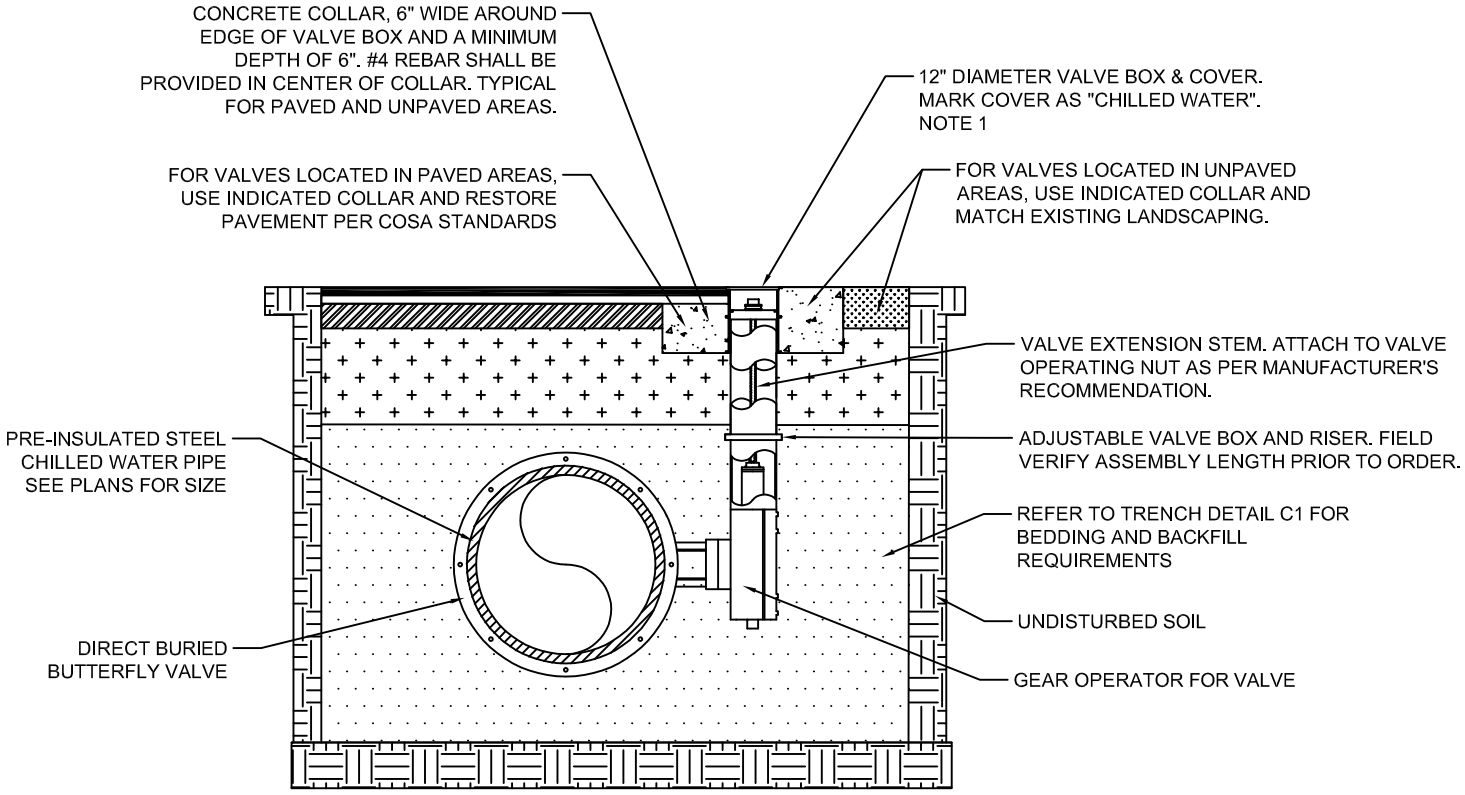
SAN ANTONIO WATER SYSTEM
SAWS DCS CUSTOMER
CONNECTION STANDARDS
SAWS JOB NO. 23-7507

REVISIONS		
NO	DATE	DESCRIPTION
0	05/10/2024	SAWS DCS - CCS

PROJ.: WJXX5901
DRAWN BY: DJM
CHECKED BY: JPS
DATE: 05/10/2024

TITLE: CHILLED WATER TRENCH DETAIL

SHEET: C1



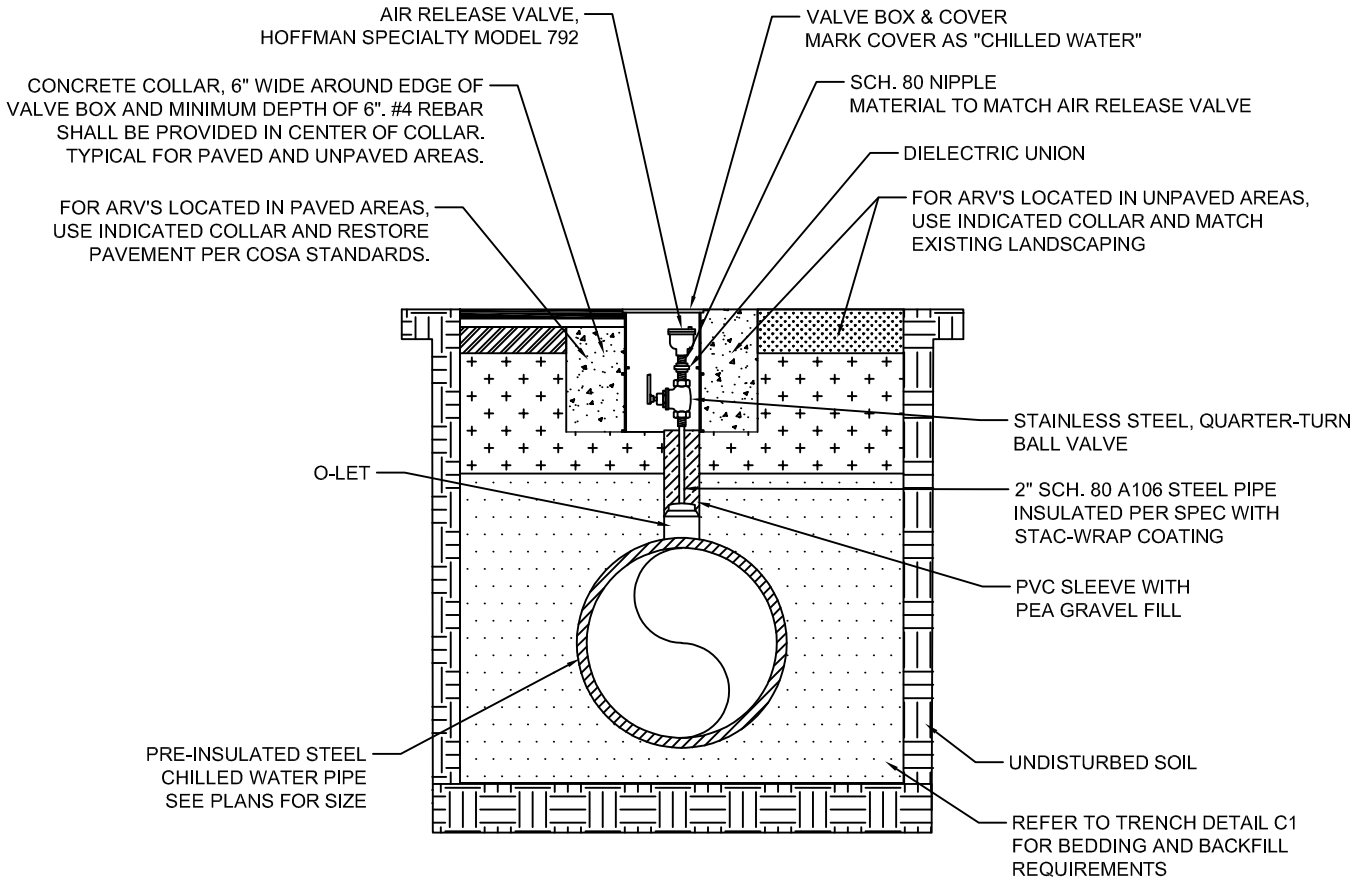
NOTES:

1. DIRECT BURIED CHILLED WATER VALVES SHALL HAVE A BRASS TAG WITH A METAL EMBED PLACED IN THE CONCRETE COLLARS SURROUNDING THE VALVE BOX. "CHWS-VLV-XX" OR "CHWR-VLV-XX" FOR CHILLED WATER SUPPLY OR CHILLED WATER RETURN VALVES, RESPECTIVELY, WHERE "XX" IS A NUMBER DESIGNATED BY THE ENGINEER/OWNER, SEE SPECIFICATION 230553.

C2 DIRECT BURIED BUTTERFLY VALVE DETAIL

N.T.S

SAN ANTONIO WATER SYSTEM SAWS DCS CUSTOMER CONNECTION STANDARDS SAWS JOB NO. 23-7507		REVISIONS NO | DATE | DESCRIPTION 0 | 05/10/2024 | SAWS DCS - CCS	PROJ.: WJXN/5901 DRAWN BY: DJM CHECKED BY: JPS DATE: 05/10/2024	TITLE: DIRECT BURIED BUTTERFLY VALVE DETAIL	SHEET: C2



NOTES:

1. LOCATE AIR RELEASE VALVES AT HIGH POINTS IN THE LATERALS.
2. IT IS PERMISSIBLE TO GROUP MULTIPLE AIR VENTS INTO A SINGLE BOX. INTERNAL BOX DIMENSIONS SHALL BE SUITABLE FOR QUANTITY OF GROUPED ARV'S WHILE ALLOWING REASONABLE MAINTENANCE ACCESS TO OPEN/CLOSE THE ISOLATION VALVE AND TURN THE AIR RELEASE VALVE FOR INSTALLATION/REMOVAL.
3. BOX AND COVER SHALL BE RATED FOR CONTINUOUS TRAFFIC.

C3

AIR RELEASE VALVE ASSEMBLY DETAIL

N.T.S

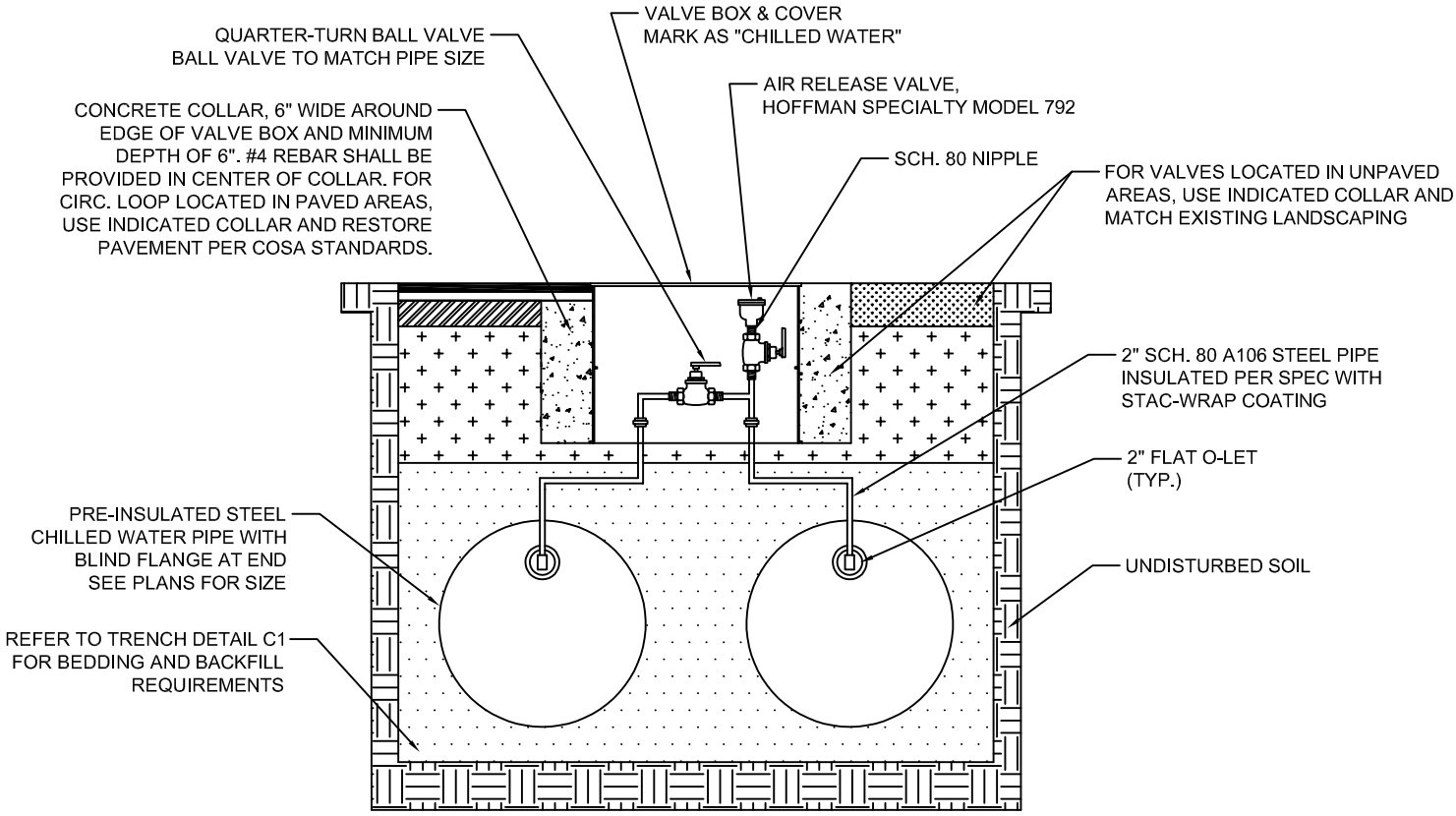
SAN ANTONIO WATER SYSTEM
SAWS DCS CUSTOMER CONNECTION STANDARDS
SAWS JOB NO. 23-7507

REVISIONS		
NO	DATE	DESCRIPTION
0	05/10/2024	SAWS DCS - CCS

PROJ.: WJXX/5901
DRAWN BY: DJM
CHECKED BY: JFS
DATE: 05/10/2024

TITLE: AIR RELEASE VALVE ASSEMBLY DETAIL

SHEET: C3



NOTES:

1. THIS DETAIL IS INTENDED FOR LATERALS WHERE ROW PIPING IS INSTALLED BUT NOT IMMEDIATELY PLACED INTO SERVICE. CIRCULATION LINE SHALL REMAIN IN SERVICE UNTIL FINAL LATERAL CONNECTION IS MADE.
2. BOX AND COVER SHALL BE RATED FOR CONTINUOUS TRAFFIC.

C4 CIRCULATION LOOP DETAIL

N.T.S

SAN ANTONIO WATER SYSTEM SAWS DCS CUSTOMER CONNECTION STANDARDS SAWS JOB NO. 23-7507		REVISIONS NO | DATE | DESCRIPTION 0 | 05/10/2024 | SAWS DCS - CCS	PROJ.: WJXX/5901 DRAWN BY: DJM CHECKED BY: JPS DATE: 05/10/2024	TITLE: CIRCULATION LOOP DETAIL	SHEET: C4

A.4 Energy Transfer Station Specifications

A.4.1 230000 – Mechanical General Provisions

A.4.2 230052 – Operation and Maintenance Manuals

A.4.3 230519 – Meters and Gages for HVAC Piping

A.4.4 230523 – General Duty Valves for HVAC Piping

A.4.5 230529 – Hangers and Supports for HVAC Piping and Equipment

A.4.6 230553 - Identification for HVAC Piping and Equipment

A.4.7 230719 - HVAC Piping Insulation

A.4.8 230900 - Instrumentation & Controls System (ICS)

A.4.9 232113 – Hydronic Piping

A.4.10 232113.13 – Underground Hydronic Piping

A.4.11 232116 – Hydronic Piping Specialties

A.4.12 232123 – Hydronic Pumps

A.4.13 232500 – Flushing, Cleaning, and Passivating Chilled Water Systems

A.4.14 235700 – Heat Exchangers for HVAC

A.4.15 260519 - Low-Voltage & Control-Voltage Electrical Power Inductors and Cables

A.4.16 260533 - Raceways and Boxes for Electrical Systems

MECHANICAL GENERAL PROVISIONS
23 00 00

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Except as modified in this section, General Conditions, Supplementary Conditions, applicable provisions of Division 1, General Requirements, and other provisions and requirements of the Contract Documents apply to work of Division 23.

B. Each section included in Division 23 - Mechanical is incomplete without the provisions stated herein.

C. Relevant provisions of the SAWS DCS Customer Connection Standards apply to Work of Division 23, Heating, Ventilating, and Air Conditioning.

1.2 DEFINITIONS

A. BAS: Building Automation System.

B. PLC: Programmable Logic Controller (used synonymously with SCADA).

C. SCADA: Supervisory Control and Data Acquisition

D. I&C: Instrumentation and Control

E. Substantial Completion: The stage in the process of the Work when the Work, or designated portion thereof, is sufficiently complete in accordance with the Contract Documents so OWNER can occupy or utilize the Work for its intended use, as evidenced by a Certificate of Substantial Completion approved by OWNER.

F. Furnish: Obtain and deliver to the job for installation by others.

G. Install: Set and final connect an equipment item furnished by others. Place item in full operating condition.

H. Installer: Any Subcontractor or Contractor providing installation or procurement services.

I. Customer: The end user of an account billed for chilled water service.

J. Contractor: Used interchangeably to indicate “Installer.” Any Subcontractor or Contractor providing installation or procurement services.

K. Owner: San Antonio Water System (SAWS)

L. Owner’s Representative: The designated representative of the Owner. The Owner’s representative will be identified at the pre-construction meeting.

M. Provide: Where the word “provide” is used, the word shall be understood to mean “the Contractor shall furnish and install” the equipment, tests, inspections, etc. referenced.

N. Existing: Existing equipment or device shall remain in service unless otherwise noted. All equipment that is not indicated as being existing shall be new.

O. HVAC: Heating, Ventilating and Air Conditioning.

P. Approved Equal: Refer to the article entitled “Materials and Equipment Substitutions” in this section.

Q. Related Work: The sections referenced under RELATED SECTIONS shall be understood to include provisions that directly affect the work being specified in the section where RELATED SECTIONS occurs.

R. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

S. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

T. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and chases.

U. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

V. The following are industry abbreviations for plastic materials:

1. CPVC: Chlorinated polyvinyl chloride plastic.

2. PE: Polyethylene plastic.

3. PVC: Polyvinyl chloride plastic.

4. HDPE: High density polyethylene

W. The following are industry abbreviations for rubber materials:

1. EPDM: Ethylene-propylene-diene terpolymer rubber.

2. NBR: Acrylonitrile-butadiene rubber.

1.3 REGULATORY REQUIREMENTS

A. Perform work in accordance with the editions, revisions, amendments, or supplements of applicable statutes, ordinances, codes, or regulations of Federal, State, and Local Authorities having jurisdiction in effect on the date bids are received.

B. Where approval standards have been established by OSHA, UL, ASME, AGA, AMCA, ANSI, ASHRAE, AHRI, NFPA, State Fire Insurance Regulatory Body, and IRI, follow these standards whether or not indicated on the Drawings and Specifications. Include cost of work required to comply with requirements of these authorities in the original proposal. Comply with ANSI/IEEE C2 where applicable.

C. Requirements in reference specifications and standards are minimum for equipment, material, and work. In instances where capacities, size, or other features of equipment, devices, or materials exceed these minimums, meet listed or shown capacities.

D. Resolve code violations discovered in Contract Documents with Engineer prior to Contract award. After Contract award, make corrections or additions necessary for compliance with applicable codes.

E. Arrange with local and state authorities and utility companies for permits, fees, and service connections for temporary and permanent water, sanitary sewer, storm and industrial waste services, verifying locations and arrangement, and pay charges including inspections.

1.4 CONTRACT DRAWINGS

A. Drawings are generally diagrammatic and are intended to encompass a system that will not interfere with the structural and architectural design of the building. Coordinate work to avoid interferences between all other trades, including but not limited to piping,

equipment, ductwork, electrical, plumbing, fire protection, ICS, architectural, and structural work.

B. Drawings are predicated on the basis of design equipment specified. Make adjustments, modifications, or changes required, due to use of other equipment. All modifications shall be approved by Engineer/Owner through the RFI process before changes are made. If field modifications are made prior to Engineer/Owner approval, removal and remedy will be at Installers' expense.

C. Should the Drawings or Specifications or SAWS Standards conflict within themselves or with each other, the better quality, or greater size or quantity of work or materials shall be performed or furnished. Coordinate corrections or additions to designs as necessary for resolution of conflicting requirements.

1.5 PROJECT/SITE CONDITIONS

A. Site Visitation: Visit the site of the proposed construction to become thoroughly familiar with details of work and working conditions, verify dimensions in the field, and advise Engineer of discrepancies before performing Work.

B. Space Requirements:

1. Consider space limitations imposed by contiguous work in location of equipment and material. Do not provide equipment or material that is not suitable in this respect.

2. Install equipment requiring service so that it is easily accessible.

3. Compare the equipment sizes with the space allotted for installation before installation and make written notice of possible conflict.

C. Route pipes through the building without interfering with other contractors' equipment or construction.

1. Provide maximum possible clear height underneath piping.

2. Install equipment requiring service so that it is easily accessible.

3. Compare the equipment sizes with the space allotted for installation before installation and make written notice of possible conflict. Disassemble large equipment to permit installation through normal room openings when required. Should written notice not be made in a timely manner, make adjustments and modifications necessary without additional compensation.

4. Timely place equipment too large to fit through finished openings and stairways.

D. Site Obstructions:

1. Drawings indicate certain information pertaining to surface and subsurface obstructions that has been taken from available drawings and surveys. Such information is not guaranteed as to accuracy of location or completeness of information by the engineer.

2. Installer shall verify with Engineer, utility companies, municipalities, and other interested parties that available information has been provided before cutting or trenching operations are begun. Verify locations given prior to and during construction.

3. Alter routing of new work should obstruction be encountered, whether or not shown on Drawings. Reroute existing lines, remove obstruction where permitted, or otherwise perform whatever work is necessary to satisfy the purpose of the new work and leave existing services and structures in a satisfactory and serviceable condition.

4. Installer shall assume total responsibility for and repair damage to existing utilities caused by construction, whether or not such existing facilities are shown. Repair existing utilities, if damaged.

5. Installer shall assume total responsibility for and repair damage to existing landscaping, street curbs, trees, site lighting, and other site features caused by construction. Provide protection of these features to minimize damage during construction. Repair vehicle tire ruts, potholes, and other vehicular damage caused by construction activities in the construction lay-down area, adjacent parking area(s), and other areas used by construction equipment. Leave the site lay-down area(s) at the conclusion of the project in same or better condition than at commencement of construction.

E. Cutting and Patching: Additions to or deviations from the noted cutting, patching and plating plans should be pursued by the Installer via the following course:

1. Submit written request to Engineer in advance of cutting or alterations.

2. Execute cutting and demolition by methods that will prevent damages to other work and will provide proper surfaces to receive installation of repairs.

3. Restore work which has been cut or removed; install new products complying with specified products, functions, tolerances, and finishes specified.

4. Escutcheon Plates.

   a. Heavy chrome-plated or nickel-plated escutcheon plates for penetrations of finished surface.

   b. Product: B&C No. 10 with concealed hinges.

5. Fit work airtight to pipes, sleeves, ducts, and other penetrations through surfaces. For fire-rated penetrations, provide assemblies in accordance with UL 1479 and ASTM E 814 utilizing products and materials equal to rating of surfaces penetrated.

1.6 COORDINATION

A. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for Mechanical installations.

B. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.

C. Openings and Chases in New Construction:

1. The General Construction trades shall build into the work all sleeves, anchors, inserts, chases, openings and recesses necessary for the installation of contract work in new construction. Each trade shall furnish and locate the required sleeves, anchors and inserts for installation. Otherwise, each trade shall perform all necessary cutting, repairing and finishing to the satisfaction of the Architect and at no increase in the contract amount.

D. Prior to installation, Coordinate all work with the work of other trades and with architectural and structural features to prevent interference between the works of different trades and to insure necessary equipment and service clearances. Should work be performed without adequate coordination so that interference occurs between works of different trades, the Contractor shall eliminate such interference by requiring necessary rework by the trades involved. Such rework shall be approved by SAWS and shall be performed at no additional cost to the contract amount.

1.7 MATERIALS AND WORKMANSHIP

A. Provide new materials and equipment of a domestic manufacturer by those regularly engaged in the production and manufacture of specified materials and equipment.

Where UL or other agency has established standards for materials, provide materials which are listed and labeled accordingly. The commercially standard items of equipment and the specific names mentioned herein are intended to identify standards of quality and performance necessary for the proper functioning of the work.

B. Work shall be performed by workmen skilled in the trade required for the work. Install materials and equipment to present a neat appearance when completed in accordance with the approved recommendations of the manufacturer and in accordance with Contract Documents.

C. Provide labor, materials, apparatus, and appliances essential to the complete functioning of the systems described or indicated herein, or which may be reasonably implied as essential whether mentioned in the Contract Documents or not.

D. Make written request for supplementary instructions to Engineer in cases of doubt as to Work intended or in the event of need for explanation thereof.

E. Performance and material requirements scheduled or specified are minimum standards acceptable. The right to judge the quality of equipment that deviates from the Contract Documents remains solely with Engineer.

F. Materials and equipment to be used on this project shall be manufactured and assembled in the United States. Contractor shall submit complete certifications and typical mill reports for review. Provide mill heat markings on pipe delivered to the job site; make available corresponding mill test reports.

1.8 MATERIAL AND EQUIPMENT SUBSTITUTIONS

A. Refer to Division 01 for substitution procedures.

B. Materials and equipment are specified to provide a level of quality and performance as a part of these Specifications.

C. Where the Specification requires the installation of a product by a reference standard (for example ASTM A-53 Grade B pipe) the contractor may install any product meeting the reference standard’s requirements and which is produced by any manufacturer.

D. Where the Specification requires the installation of a particular manufacturer’s model or an approved equal by several other listed manufacturers, the contractor shall provide the particular product specified or a comparable item with all the specified

characteristics and accessories which is manufactured by one of the other listed manufacturers.

E. Where the Specification requires the installation of a particular manufacturer's model without an approved equal; the contractor shall provide the product specified. There is no option and no substitutions will be permitted.

F. Equipment larger in size then shown on the drawings will not be acceptable unless it can be demonstrated that sufficient space exists for proper installation, operation, maintenance, and future replacement.

G. The size of mechanical equipment indicated on the drawings is based on the dimensions of a particular manufacturer. While other manufacturers may be acceptable, it is the responsibility of the Contractor to determine if equipment the Contractor proposes to furnish will fit into the space. Fabrication Drawings shall be prepared when required by the A/E or Owner, at no additional cost, to indicate a suitable arrangement.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Follow the manufacturer's directions completely in the delivery, storage, and handling of equipment and materials.

B. Store equipment in a clean, dry place protected from other construction. While stored maintain factory wrapping or tightly cover and protect equipment against dirt, water, construction debris, chemical, physical or weather damage, traffic and theft.

C. Adequately brace and package equipment to prevent breakage and distortion while in transit.

1.10 WELDING

A. Refer to Section 232113 – Hydronic Piping.

B. Weld piping in accordance with qualified procedures using performance qualified welders and welding operators. Qualified procedures and welders in accordance with ASME Section IX. Welding procedures qualified by others and welders and welding operators qualified by another employer may be accepted as permitted by ASME B31.1 and B31.9. Notify the Engineer 24 hours in advance of tests, and perform the tests at the work site if practicable. Furnish Engineer with a copy of qualified

procedures and a list of names and identification symbols of qualified welders and welding operators. Apply welders or welding operator's assigned symbols near each weld they make as permanent record.

1.11 PAINTING

A. Properly prepare surfaces to receive paint. Verify primer and paint are rated for application.

B. Comply with manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual" applicable to preparation procedures, paints, substrates and coating systems indicated below.

C. Chilled Water Piping: Provide surface preparation and coating on carbon steel chilled water piping. Touch-up coating at welds, joints, and elsewhere as exposed and uncoated prior to the pipe being insulated.

D. Surface Preparation: SSPC SP-10 Near White Metal Blast, 2-3 angular profile.

E. Coating: 2-coat, Macropoxy 646 Epoxy applied at 5-10 mils dry film thickness per coat.

F. Color Scheme: Utilize Owner's preferred paint color scheme.

G. Repair damage to factory painted finishes.

H. Remove splattered and incidental paint from mechanical equipment.

1.12 OPERATING INSTRUCTIONS

A. Provide services of authorized representatives of manufacturer to ensure that the equipment is installed according to the manufacturer's recommendations, is operating properly, and to instruct Owner's operating personnel during start-up and operating tests of complete mechanical systems. Prove operation of equipment to Engineer. Notify Engineer seven days prior to beginning equipment start-up.

B. Certify in writing that these services have been performed.

1.13 SERVICE

A. Inspect, clean, and service strainers immediately prior to final acceptance of project.

B. Provide protective guard for gears, couplings, projecting set screws, keys, and other rotating parts which are located so a person might come in close proximity with. Construct protective guard around angle iron frame, securely bolted to apparatus; comply with safety requirements. Install guard to completely enclose drives and pulleys, and not interfere with lubrication of equipment.

C. Place mechanical systems in complete working order, and clean and polish fixtures, equipment, and materials thoroughly returning to "as new" condition prior to request for final review.

1.14 PROJECT RECORD DOCUMENTS

A. Except as modified with more stringent requirements herein, perform and provide Project record documents in accordance with SAWS Standards.

B. Maintain a set of Contract Documents at the job site for the purpose of recording final size, location, and interrelation of work under this Division. Mark this set of drawings as the job progresses to indicate "as-built" location of equipment, piping and all valves and accessories, ductwork and all accessories, and controls components.

C. The contractor shall transfer the information from the marked up set described above and turn over PDF files of this neatly marked set of reproducible Drawings representing the "as installed" work to the Architect/Engineers for verification and subsequent transmittal to the Owner along with the updated BIM model and CAD drawings. The Contractor shall refer to Division 01 of these Specifications for additional information. These Drawings shall include as a minimum:

1. Drawing changes or additions as a result of Addendum
2. Drawing changes or additions as a result of RFI responses.
3. Drawing changes or additions as a result of submittal review comments.
4. Accurate, dimensioned locations of all underground utilities, services and systems.
5. Identification of equipment work shown on Alternates as to whether alternates were accepted, and work actually installed.

6. Drawing changes or additions as a result of Change Orders

D. Clearly and accurately delineate work by dimensions on record drawings as installed, with equipment locations identified by at least two dimensions to permanent structures.

E. Provide and submit a 3D BIM model (Revit, AutoCAD 3D, Navisworks) of mechanical equipment, piping, ductwork, and all accessories installed or modified as part of this project.

F. Provide certified final record drawings, marked "PROJECT RECORD DRAWINGS," and signed and dated by Contractor at conclusion of project. Provide CAD files of record drawings in AutoCAD 2010 latest version.

1.15 FINAL REVIEW

A. Obtain necessary Certificates of Occupancy from local authorities.

B. Submit final approved operation and maintenance manuals including approved submittals, test reports, and "PROJECT RECORD DRAWINGS" prior to requesting final payment. Delivery of operation and maintenance manuals is a condition of final acceptance.

1.16 GUARANTEE

A. Guarantee materials, parts, and labor for Work for one year from the date of issuance of occupancy permit. During that period, make good faults or imperfections that may arise due to defects or omissions in materials or workmanship with no additional compensation and as directed by A/E.

B. Certain items of equipment are covered by the manufacturer's warranty of longer durations.

PART 2 - PRODUCTS

2.1 SPECIAL TOOLS

A. Contractor shall provide Owner all special tools required to maintain equipment installed under this contract. Coordinate with equipment manufacturers and submit

tool manufacturer, tool description, tool part number, recommended tool quantity, and schedule of value.

2.2 SPARE PARTS INVENTORY

A. The Contractor shall provide a spare part inventory consisting of the following:

1. Spare valve seals and packings for each model and size valve.

2. The Contractor shall submit list of recommended spare parts for equipment installed under this contract in addition to those listed above. Submit part description, part number, recommended inventory quantity, and schedule of value such that the Owner may choose at discretion which spare parts to be included for purchase.

3. Spare part inventory shall be submitted at least 60 days in advance of substantial completion.

PART 3 - EXECUTION

Not Used.

END OF SECTION 230000

OPERATION AND MAINTENANCE MANUALS
23 00 52

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Preparation and submission of operation and maintenance manuals.

B. Each section included in Division 23 - Mechanical incorporates this section by reference and is incomplete without the provisions stated herein.

1.2 RELATED SECTIONS

A. Section 230000 - Mechanical General Provisions.

1.3 PREPARATION

A. Furnish four copies of complete operation and maintenance instructions, service manuals and parts list applicable to each manufactured item of equipment furnished. Bind operation and maintenance information in four separate loose-leaf binders and deliver to the Engineer at least four weeks prior to final review of the project.

1. In addition to the binders, provide an electronic copy in .PDF format of the O&M manuals.

B. Organize binders to contain like equipment such as pumps, chillers, piping, valves, etc., in separate divisions. Provide a complete double index for each binder to include:

1. An alphabetized list of the products by name.

2. An alphabetized list of manufacturers whose products have been incorporated in the work, together with their addresses and the name, addresses and telephone numbers of the local sales representative or supplier.

C. For each section of product, equipment or system, organize the data as follows:

1. Furnish a general description of the equipment or system listing the major components, intended service and other general data.

2. Furnish technical data including nameplate data, design parameters, ratings, capacity, performance data, operating curves, characteristics and the like. Clearly distinguish between information which does and does not apply.
3. List warnings and cautions to be observed during both installation and operations.
4. Fully detailed installation and operation instructions including special tools required, alignment instructions, start-up, and shut-down sequences.
5. Furnish maintenance, service and repair instructions including maintenance and service schedules, materials, and methods for performing routine and annual service.
6. Furnish a troubleshooting guide and check list indicating common failures, test methods and procedures for determining component fault or failure.
7. Furnish a spare parts list indicating part and order number with name, address, and telephone number of supplier. Include current prices of replacement parts and supplies. Indicate spare parts already furnished and quantity furnished, Refer to Section 230000 - Mechanical General Provisions.
8. Furnish diagrams including controls, wiring, installation or operation of the equipment or system.
9. Furnish copies of all approved submittals.
10. Furnish copies of all test reports.
11. Print copies of the "PROJECT RECORD DRAWINGS." Refer to Section 230000.
12. Furnish all warranties and guarantees.

PART 2 - PRODUCTS

Not Used.

PART 3 - EXECUTION

Not Used.

END OF SECTION 230052

METERS AND GAGES FOR HVAC PIPING
23 05 19

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
1. Dial-type Bimetal thermometers.
2. Thermowells.
3. Dial-type pressure gages.
4. Gage attachments.
5. Test plugs.
6. Test-plug kits.

B. Related Requirements:
1. Section 230900 “Instrumentation & Control Systems (ICS)” for flow meters.

1.3 ACTION SUBMITTALS

A. Product Data: Data sheets shall be clearly marked to reflect actual product and options furnished for each instrument including: description, model, operating range, accuracy, dimensions, electrical characteristics and connections, environmental operating ranges, and material finishes.

1.4 INFORMATIONAL SUBMITTALS

A. Product Certificates: For each type of meter and gage.
1. Factory Calibration Data
2. Field Checkout Data

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For meters and gages to include in operation and maintenance manuals. Manual that shows manufacturer/supplier information (name, address, telephone), theory of operation, calibration instructions, installation instructions and diagrams, assembly views, troubleshooting special tools list, warranties, replacement parts and recommended spare parts list.

PART 2 - PRODUCTS

2.1 GENERAL

A. Provide local process gauges with dial sizes between 3-5 inches in diameter unless operating floor reading location is further than 3 feet when 6 to 8 inch gauges will be required.

B. Provide analog process gauge scales so that expected normal operating value is approximately ½ to 2/3 of full-scale range.

C. Provide instruments with wetted parts that are compatible with the intended service.

2.2 BI-METAL DIAL TYPE THERMOMETERS

A. Metal-Case, Industrial-Style, Liquid-in-Glass Thermometers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Ashcroft
   b. Tel-Tru.
   c. Weiss Instruments, Inc.

2. Standard: ASTM E1 and e77; ASME B40.200.
3. Case: Stainless Steel, hermetically sealed.
4. Case Form: Adjustable angle unless otherwise indicated.
5. Window: Glass.
6. Stem: Aluminum and of length to suit installation.
   a. Design for Thermowell Installation: Bare stem.
   b. Diameter of 0.250 inches.

7. Connector: 1-1/4 inches, with ASME B1.1 screw threads.
8. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.

2.3 THERMOWELLS

A. Thermowells:

1. Manufacturer: Thermowell to be ordered from same manufacturer as temperature gage.

2. Standard: ASME B40.200.
3. Description: Pressure-tight, socket-type fitting made for insertion in piping tee fitting.
4. Material for Use with Copper Tubing: CUNI.
5. Material for Use with Steel Piping: CRES.
6. Type: Tapered shank unless straight or stepped shank is indicated.
7. External Threads: NPS 1/2, NPS 3/4, or NPS 1, ASME B1.20.1 pipe threads.
8. Internal Threads: 1/2, 3/4, and 1 inch, with ASME B1.1 screw threads.
9. Bore: Diameter required to match thermometer bulb or stem.
10. Insertion Length: Length required to match thermometer bulb or stem.
11. Lagging Extension: Include on thermowells for insulated piping and tubing.
12. Bushings: For converting size of thermowell's internal screw thread to size of thermometer connection.

B. Heat-Transfer Medium: Mixture of graphite and glycerin.

2.4 DIAL-TYPE PRESSURE GAGES

A. Direct-Mounted, Metal-Case, Dial-Type Pressure Gages:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Ashcroft Inc.
   b. No-Shok.
   c. Tel-Tru.
   d. Weiss Instruments, Inc.

2. Standard: ASME B40.100.
3. Case: Liquid-filled, Sealed type(s); cast aluminum or drawn steel; 4-1/2-inch nominal diameter.
4. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
5. Pressure Connection: Brass, with NPS 1/2, ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
6. Movement: Mechanical, with link to pressure element and connection to pointer.
7. Dial: Nonreflective aluminum with permanently etched scale markings graduated in psi.
8. Pointer: Black-colored metal.

9. Window: Glass.
10. Ring: Stainless steel.
11. Accuracy: Grade A, plus or minus 1 percent of middle half of scale range.

2.5 GAGE ATTACHMENTS

A. Snubbers: ASME B40.100,316 stainless steel to protect against surges and shocks. Include extension for use on insulated piping.

B. Protection: Overload stop or blowout back.

C. Liquid fill: Silicone Oil

D. Valves: Stainless-steel needle, 2-way to allow for in-place calibration.

2.6 TEST PLUGS

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

1. Flow Design, Inc.
2. Peterson Equipment Co., Inc.
3. Trerice, H. O. Co.
4. WATTS.
5. Weiss Instruments, Inc.

B. Description: Test-station fitting made for insertion in piping tee fitting.

C. Body: Brass or stainless steel with core inserts and gasketed and threaded cap. Include extended stem on units to be installed in insulated piping.

D. Thread Size: NPS 1/2, ASME B1.20.1 pipe thread.

E. Minimum Pressure and Temperature Rating: 500 psig at 200 deg F.

F. Core Inserts: Chlorosulfonated polyethylene synthetic or EPDM self-sealing rubber.

2.7 TEST-PLUG KITS

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

1. Flow Design, Inc.
2. Peterson Equipment Co., Inc.

3. Trerice, H. O. Co.
4. WATTS.
5. Weiss Instruments, Inc.

B. Furnish one test-plug kit(s) containing two thermometer(s), one pressure gage and adapter, and carrying case. Thermometer sensing elements, pressure gage, and adapter probes shall be of diameter to fit test plugs and of length to project into piping.

C. Low-Range Thermometer: Small, bimetallic insertion type with 1- to 2-inch- diameter dial and tapered-end sensing element. Dial range shall be at least 25 to 125 deg F.

D. High-Range Thermometer: Small, bimetallic insertion type with 1- to 2-inch- diameter dial and tapered-end sensing element. Dial range shall be at least 0 to 220 deg F.

E. Pressure Gage: Small, Bourdon-tube insertion type with 2- to 3-inch- diameter dial and probe. Dial range shall be at least 0 to 200 psig.

F. Carrying Case: Metal or plastic, with formed instrument padding.

PART 3 - EXECUTION

3.1 GENERAL

A. Contractor shall have overall responsibility for the installation, commissioning, successful operation and performance of the instrumentation system.

B. Locate/mount equipment so that maintenance personnel have clear access for calibration, repair, and replacement services.

3.2 INSTALLATION

A. Install thermowells with socket extending to center of pipe and in vertical position in piping tees.

B. Install thermowells of sizes required to match thermometer connectors. Include bushings if required to match sizes.

C. Install thermowells with extension on insulated piping.

D. Fill thermowells with heat-transfer medium.

E. Install direct-mounted thermometers in thermowells and adjust vertical and tilted positions.

F. Install direct-mounted thermometers in thermowells and adjust vertical and tilted positions.

G. Install direct-mounted pressure gages in piping tees with pressure gage located on pipe at the most readable position.

H. Install remote-mounted pressure gages on panel.

I. Install valve and snubber in piping for each pressure gage for fluids (except steam).

J. Install test plugs in piping tees.

K. Install permanent indicators on walls or brackets in accessible and readable positions.

L. Install connection fittings in accessible locations for attachment to portable indicators.

M. Install thermometers as shown on drawings, including in the following locations:
1. Inlet and outlet of each heat exchanger source and load sides.

N. Install pressure gages as shown on drawings, including in the following locations:
1. Inlet and outlet of strainers.
2. Inlet and outlet of each heat exchanger source and load sides.

3.3 CONNECTIONS

A. Install meters and gages adjacent to machines and equipment to allow space for service and maintenance of meters, gages, machines, and equipment.

3.4 ADJUSTING

A. After installation, calibrate meters according to manufacturer's written instructions. Record data points – 0%, 50%, 100%, 50%, 0% (ramp up & ramp down); record data using NIST traceable test instrumentation.

B. Adjust faces of meters and gages to proper angle for best visibility.

3.5 FIELD QUALITY CONTROL

A. Inspections:
1. Verify installations against the system flow & piping drawings and instrumentation installation details.
2. Visually inspect for damage; if damage is observed it shall be recorded and corrective action taken.
3. Verify removal of temporary protective devices, restraints, and stops.

4. Verify that piping and tubing system is properly aligned.
5. Check flanges/gaskets for conditions that might cause leakage and bolting (proper size, length, and material).

END OF SECTION 230519

GENERAL DUTY VALVES FOR HVAC PIPING
23 05 23

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
1. Iron, single-flange butterfly valves
2. High performance butterfly valves.
3. Bronze ball valves.
4. Stainless steel ball valves
5. Chainwheels.

1.3 DEFINITIONS

A. CWP: Cold working pressure.

B. EPDM: Ethylene propylene copolymer rubber.

C. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.

D. NRS: Nonrising stem.

E. OS&Y: Outside screw and yoke.

F. RS: Rising stem.

G. SWP: Steam working pressure.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of valve.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:

1. Protect internal parts against rust and corrosion.
2. Protect threads, flange faces, grooves, and weld ends.
3. Set butterfly valves closed or slightly open.
4. Set ball valves open to minimize exposure of functional surfaces.

B. Use the following precautions during storage:

1. Maintain valve end protection.
2. Store valves indoors and maintain at higher-than-ambient-dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.

B. ASME Compliance:

1. ASME B16.1 for flanges on iron valves.
2. ASME B16.5 for pipe flanges and flanged fittings, NPS 1/2 through NPS 24.
3. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
4. ASME B16.18 for solder joint.
5. ASME B31.9 for building services piping valves.
6. ASME B1.20.1 for threads for threaded-end valves.

C. Refer to valve schedule articles for applications of valves.

D. AWWA Compliance: Comply with AWWA C606 for grooved-end connections.

E. Bronze valves shall be made with dezincification-resistant materials. Bronze valves made with copper alloy (brass) containing more than 15 percent zinc are not permitted.

F. Valve Pressure-Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

G. Valve Sizes: Same as upstream piping unless otherwise indicated.

H. Valve Actuator Types:

1. Gear Actuator: For valves NPS 8 and larger.
2. Handlever: For valves NPS 6 and smaller.
3. Chainwheel: Device for attachment to gear, stem, or other actuator of size and with chain for mounting height, according to "Valve Installation" Article.

I. Valves in Insulated Piping: With 2-inch stem extensions with extended necks.
1. Include 2-inch stem extensions.
2. Extended operating handle of nonthermal-conductive material, and protective sleeves that allow operation of valves without breaking the vapor seals or disturbing insulation.
3. Memory stops that are fully adjustable after insulation is applied.

J. Valve Bypass and Drain Connections: MSS SP-45.

K. RS Valves in Insulated Piping: With 2-inch stem extensions.

2.2 IRON, SINGLE-FLANGE BUTTERFLY VALVES

A. Iron, Single-Flange Butterfly Valves with Aluminum-Bronze Disc:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Bray Controls. (Basis of Design)
b. DeZURIK.
c. Milwaukee Valve Company.

2. Description:

a. Standard: MSS SP-67, Type I.
b. Pressure Rating, for 2 to 20” valves:
1) Bidirectional Bubble-tight Shutoff: 250 psig
2) Dead-End Service Shutoff: 250 psig
c. Pressure Rating, for 24 to 30” valves:
1) Bidirectional Bubble-tight Shutoff: 232 psig
2) Dead-End Service Shutoff: 150 psig
d. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
e. Body Material: Polyester coated ASTM A536, ductile iron.

f. Seat: Resilient replaceable EPDM.
g. Stem: One- or two-piece stainless steel.
h. Disc: Aluminum bronze.
i. End Connection: ASME Class 150 flanges
j. Service: Bidirectional.

2.3 HIGH-PERFORMANCE BUTTERFLY VALVES

A. Class 300, Single-Flange, High-Performance Butterfly Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Bray Controls; McCannalok (Basis of Design)
   b. Crane; Crane Energy Flow Solutions.
   c. Durco
   d. Jamesbury
   e. Fisher
   f. Pratt
2. Description:
   a. Standard: MSS SP-68.
   b. CWP Rating: 720 psig at 100 deg F.
   c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
   d. Body Material: Carbon steel, ductile iron, or stainless steel.
   e. Seat: Reinforced PTFE or metal with ANSI/FCI 70.2 Class IV maximum leakage**.**
   f. Stem: Stainless steel; offset from seat plane.
   g. Disc: 316 Stainless steel.
   h. Service: Bidirectional.

2.4 BRONZE BALL VALVES

A. Bronze Ball Valves, Two-Piece with Full Port and Stainless-Steel Trim:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Apollo Flow Controls; Conbraco Industries, Inc.
   b. Crane; Crane Energy Flow Solutions.
   c. Hammond Valve.
   d. Milwaukee Valve Company.
   e. WATTS.
2. Description:
   a. Standard: MSS SP-110.
   b. SWP Rating: 150 psig.
   c. CWP Rating: 600 psig.
   d. Body Design: Two piece.

e. Body Material: Bronze.
f. Ends: Threaded.
g. Seats: PTFE.
h. Stem: Stainless steel.
i. Ball: Stainless steel, vented.
j. Port: Full.

2.5 STAINLESS STEEL BALL VALVES

A. Stainless Steel Ball Valves, Two-Piece with Full Port and Stainless-Steel Trim:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Apollo Flow Controls; Conbraco Industries, Inc.
b. Crane; Crane Energy Flow Solutions.
c. Hammond Valve.
d. Milwaukee Valve Company.
e. WATTS.
2. Description:
a. Standard: MSS SP-110.
b. SWP Rating: 150 psig.
c. CWP Rating: 2,000 psig.
d. Body Design: Two piece.
e. Body Material: Stainless Steel.
f. Ends: Threaded.
g. Seats: PTFE.
h. Stem: Stainless steel.
i. Ball: Stainless steel, vented.
j. Port: Full.

2.6 CHAINWHEELS

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

1. Babbitt Steam Specialty Co.
2. Roto Hammer Industries.
3. Trumbull Industries.

B. Description: Valve actuation assembly with sprocket rim, chain guides, chain, and attachment brackets for mounting chainwheels directly to hand wheels.

1. Sprocket Rim with Chain Guides: Ductile iron, of type and size required for valve. Include zinc or epoxy coating.

2. Chain: Hot-dip, galvanized steel, of size required to fit sprocket rim.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.

C. Examine threads on valve and mating pipe for form and cleanliness.

D. Examine mating flange faces for damage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.

E. Do not attempt to repair defective valves; replace with new valves.

3.2 VALVE INSTALLATION

A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.

B. Locate valves for easy access and provide separate support where necessary.

C. Install valves in horizontal piping with stem at or above center of pipe.

D. Install valves in position to allow full stem movement.

E. Install chainwheels on operators for globe, gate, and butterfly valves NPS 4 and larger and more than 96 inches above floor. Extend chains to 60 inches above finished floor.

F. Install valve tags. Comply with requirements in Section 230553 "Identification for HVAC Piping and Equipment" for valve tags and schedules.

3.3 ADJUSTING

A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

3.4 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

A. If valves with specified CWP ratings are unavailable, the same types of valves with higher CWP ratings may be substituted.

B. Select valves with the following end connections:
   1. For Steel Piping, NPS 2 and Smaller: Threaded ends.
   2. For Steel Piping, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules.
   3. For Steel Piping, NPS 5 and Larger: Flanged ends.

C. Refer to drawings for valve type and locations. Refer to Applications paragraphs below for further detail.

3.5 CHILLED WATER VALVE SCHEDULE

A. Pipe NPS 2 and Smaller: Ball valves.
   1. Bronze or stainless-steel ball valves, two piece, with stainless-steel trim, full port, threaded-joint ends.

B. Pipe NPS 2-1/2 and Larger: Butterfly valves.
   1. System design pressure 150 psig and less: Iron, Single-Flange Butterfly Valves
   2. System design pressure greater than 150 psig: High-Performance Butterfly Valves

END OF SECTION 230523

HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT
23 05 29

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Metal pipe hangers and supports.
2. Trapeze pipe hangers.
3. Thermal-hanger shield inserts.
4. Fastener systems.
5. Equipment supports.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Signed and sealed by a qualified professional engineer. Show fabrication and installation details and include calculations for the following; include Product Data for components:

1. Trapeze pipe hangers.
2. Pipe stands.
3. Equipment supports.

C. Delegated-Design Submittal: For all hangers and supports to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Detail fabrication and assembly of each hanger and support assembly. An itemized bill of material is acceptable.
2. Include design calculations for selecting hangers and supports.
3. Building connection details for each type, size, and building condition for each hanger and support.

4. Stanchions in excess of 36” in height.

1.4 INFORMATIONAL SUBMITTALS

A. Welding certificates.

1.5 QUALITY ASSURANCE

A. Structural-Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code, Section IX.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Provide an engineered hanger system for the piping associated with this project. Hanger system shall include hangers, rods, attachments, rollers, clamps and all components necessary to support the piping from the structure. Contractor shall refer to standard pipe support details depicted on the drawings for minimum design and material requirements for the types of supports anticipated for this project.

B. The contractor shall provide a hanger system in accordance with ASME B31.9 based on the actual equipment and piping installed.

C. Engage a qualified professional engineer to design building attachments, pipe hangers and equipment supports.

D. Structural Performance: Hangers and supports for HVAC piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.

1. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

2.2 METAL PIPE HANGERS AND SUPPORTS

A. Carbon-Steel Pipe Hangers and Supports:

1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
2. Galvanized Metallic Coatings: hot-dip galvanized
3. Hanger Rods: Continuous-thread rod, nuts, and washer made of galvanized carbon steel.

2.3 TRAPEZE PIPE HANGERS

A. Description: MSS SP-58, Type 59, shop- or field-fabricated pipe-support assembly made from structural carbon-steel shapes with MSS SP-58 with hot-dipped galvanized carbon-steel hanger rods, nuts, saddles, and U-bolts.
   1. Galvanized Metallic Coatings: hot-dip galvanized

2.4 THERMAL-HANGER SHIELD INSERTS

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

   1. National Pipe Hanger Corporation.
   2. Pipe Shields Inc.
   3. Piping Technology & Products, Inc.
   4. Rilco Manufacturing Co., Inc.

B. Insulation-Insert Material for Cold Piping: ASTM C552, Type II cellular glass with 100-psi or ASTM C591, Type VI, Grade 1 polyisocyanurate with 125-psi minimum compressive strength and vapor barrier.

C. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.

D. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.

E. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

F. Insert Thickness: Same thickness as adjoining pipe insulation.

2.5 FASTENER SYSTEMS

A. Mechanical-Expansion Anchors: Insert-wedge-type anchors for use in hardened portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. B-line, an Eaton business.
b. Hilti, Inc.
c. ITW Ramset/Red Head; Illinois Tool Works, Inc.

2. Indoor Applications: Zinc-coated or stainless-steel.
3. Outdoor Applications: Stainless steel.

2.6 MATERIALS

A. Aluminum: ASTM B221.

B. Carbon Steel: ASTM A1011/A1011M.
1. All carbon steel installed in exterior applications shall be hot-dip galvanized.

C. Structural Steel: ASTM A36/A36M, carbon-steel plates, shapes, and bars; galvanized.

D. Stainless Steel: ASTM A240/A240M.

E. Threaded Rods: Continuously threaded. Zinc-plated or galvanized steel for indoor applications and stainless steel for outdoor applications. Mating nuts and washers of similar materials as rods.

F. Grout: ASTM C1107/C1107M, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.

1. Properties: Nonstaining, noncorrosive, and nongaseous.
2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.1 APPLICATION

A. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.

3.2 HANGER AND SUPPORT INSTALLATION

A. Metal Pipe-Hanger Installation: Comply with MSS SP-58. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.

B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-58. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.

1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
2. Field fabricate from ASTM A36/A36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.

C. Metal Framing Systems: Unistrut shall not be used for piping supports.

D. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.

E. Fastener System Installation:
1. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.

F. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.

G. Equipment Support Installation: Fabricate from welded-structural-steel shapes.

H. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

I. Install lateral bracing with pipe hangers and supports to prevent swaying.

J. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.

K. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

L. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.

M. Insulated Piping:

1. Attach clamps and spacers to piping.
   a. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.

b. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.

2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.

   a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.

3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.

   a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.

4. Shield Dimensions for Pipe: Not less than the following:

   a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
   b. NPS 4: 12 inches long and 0.06 inch thick.
   c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.
   d. NPS 8 to NPS 14: 24 inches long and 0.075 inch thick.
   e. NPS 16 to NPS 24: 24 inches long and 0.105 inch thick.

5. Pipes NPS 8 and Larger: Include inserts of length at least as long as protective shield.
6. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

N. Install permanent supports to facilitate removal of serviceable components without the need to install temporary supports.

O. Refer to drawings for additional pipe hangers and support types and requirements.

3.3 METAL FABRICATIONS

A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers.

B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.

C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.

2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.4 ADJUSTING

A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

3.5 PAINTING

A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils.

B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A780/A780M.

3.6 HANGER AND SUPPORT SCHEDULE

A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.

B. Comply with MSS SP-58 for pipe-hanger selections and applications that are not specified in piping system Sections.

C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finish.

D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.

E. Use hot dip galvanized steel pipe hangers and supports, metal trapeze pipe hangers, and attachments.

F. Use padded hangers for piping that is subject to scratching.

G. Use thermal-hanger shield inserts for insulated piping and tubing.

H. Horizontal-Piping Hangers and Supports: Unless otherwise indicated on the drawings and except as specified in piping system Sections, install the following types:

1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30.
2. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30.
3. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.
4. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.
5. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes NPS 2-1/2 to NPS 36 if vertical adjustment is required, with steel-pipe base stanchion support and cast-iron floor flange.
6. Single-Pipe Rolls (MSS Type 41): For suspension of pipes NPS 1 to NPS 30, from two rods if longitudinal movement caused by expansion and contraction might occur.
7. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes NPS 2-1/2 to NPS 24, from single rod if horizontal movement caused by expansion and contraction might occur.

I. Vertical-Piping Clamps: Unless otherwise indicated on the drawings and except as specified in piping system Sections, install the following types:

1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24.
2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 30 if longer ends or higher load capacity are required for riser clamps.
3. On pipes NPS 2-1/2 to 6, provide two (2) 1/2” x 1” x 3” buck lugs welded to the pipe to rest on the Riser Clamps at each location.
4. On pipes NPS 8 and larger, provide four (4) 1/2” x 1” x 3” buck lugs welded to the pipe to rest on the Riser Clamps at each location.

J. Hanger-Rod Attachments: Unless otherwise indicated on the drawings and except as specified in piping system Sections, install the following types:

1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
2. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.

K. Building Attachments: Unless otherwise indicated on the drawings and except as specified in piping system Sections, install the following types:

1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction, to attach to top flange of structural shape.
3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
6. C-Clamps (MSS Type 23): For structural shapes.
7. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
8. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
9. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
10. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:

    a. Light (MSS Type 31): 750 lb.
    b. Medium (MSS Type 32): 1500 lb.
    c. Heavy (MSS Type 33): 3000 lb.

L. Saddles and Shields: Unless otherwise indicated on the drawings and except as specified in piping system Sections, install the following types:

1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.

M. Spring Hangers and Supports: Unless otherwise indicated on the drawings and except as specified in piping system Sections, install the following types:
1. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.
2. Variable-Spring Hangers (MSS Type 51): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from hanger.

N. Comply with MSS SP-58 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.

O. Use mechanical-expansion anchors instead of building attachments where required in concrete construction.

END OF SECTION 230529

IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT
23 05 53

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Equipment labels.
2. Pipe labels.
3. Valve tags.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Samples: For color, letter style, and graphic representation required for each identification material and device.

C. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.

D. Valve Schedules: For each piping system to include in maintenance manuals.
1. Valve numbering scheme.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

A. Plastic Labels for Equipment:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Brady Corporation.
b. Brimar Industries, Inc.
c. Seton Identification Products.

2. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.
3. Letter Color: Black.
4. Background Color: White.
5. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
6. Minimum Label Size: Length and width vary for required label content, but not less than 3 inch by 1 inch.
7. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.
8. Fasteners: Stainless-steel rivets or self-tapping screws.
9. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

B. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), and the Specification Section number and title where equipment is specified.

C. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch bond paper. Tabulate equipment identification number, and identify Drawing numbers where equipment is indicated (plans, details, and schedules) and the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.
1. Equipment Label Text:
a. Heat Exchangers: “HX-1”, “HX-2”, or as indicated on the drawings.

2.2 PIPE LABELS

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

1. Brady Corporation.
2. Brimar Industries, Inc.
3. Seton Identification Products.

B. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction according to ASME A13.1.

C. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.

D. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.

E. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings; also include pipe size and an arrow indicating flow direction.

1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions or as separate unit on each pipe label to indicate flow direction.
2. Lettering Size: At least 1-1/2 inch for viewing distances up to 72 inches and proportionately larger lettering for greater viewing distances.
3. Pipe Label Text:
   a. SAWS Chilled Water Supply: “SAWS CHWS”, or as indicated on the drawings.
   b. SAWS Chilled Water Return: “SAWS CHWR”, or as indicated on the drawings.
   c. Building Chilled Water Supply: “BLDG CHWS”, or as indicated on the drawings.
   d. Building Chilled Water Return: “BLDG CHWR”, or as indicated on the drawings.

2.3 VALVE TAGS

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

1. Brady Corporation.
2. Brimar Industries, Inc.
3. Seton Identification Products.

B. Description: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers.

1. Tag Material: Brass, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
2. Fasteners: Brass beaded chain.

C. Valve Schedules: For each piping system, on 8-1/2-by-11-inch bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.
1. Valve Tag Text:
   a. SAWS Chilled Water Supply Isolation Valve: “S-CHWS-001”, or as indicated on the drawings.

b. SAWS Chilled Water Return Isolation Valve: “S-CHWR-001”, or as indicated on the drawings.
c. Building Chilled Water Supply Isolation Valve: “B-CHWS-001”, or as indicated on the drawings.
d. Building Chilled Water Return Isolation Valve: “B-CHWR-001”, or as indicated on the drawings.
e. SAWS Flow Control Valve: “S-FCV-001”, or as indicated on the drawing.

2. Valve-tag schedule shall be included in operation and maintenance data.

PART 3 - EXECUTION

3.1 PREPARATION

A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.2 GENERAL INSTALLATION REQUIREMENTS

A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

B. Coordinate installation of identifying devices with locations of access panels and doors.

C. Install identifying devices before installing acoustical ceilings and similar concealment.

3.3 EQUIPMENT LABEL INSTALLATION

A. Install or permanently fasten labels on each major item of mechanical equipment.

B. Locate equipment labels where accessible and visible.

3.4 PIPE LABEL INSTALLATION

A. Pipe Label Locations: Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:

1. Near each valve and control device.
2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.

3. Near penetrations and on both sides of through walls, floors, ceilings, and inaccessible enclosures.
4. At access doors, manholes, and similar access points that permit view of concealed piping.
5. Near major equipment items and other points of origination and termination.
6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.
7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.

B. Directional Flow Arrows: Arrows shall be used to indicate direction of flow in pipes, including pipes where flow is allowed in both directions.

C. Pipe Label Color Schedule:

1. Chilled-Water Piping: White letters on a safety-green background.

3.5 VALVE-TAG INSTALLATION

A. Install tags on valves and control devices in piping systems, except check valves, valves within factory-fabricated equipment units, faucets, convenience and lawn-watering hose connections, and HVAC terminal devices and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.

B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following subparagraphs:

1. Valve-Tag Size and Shape:

a. Chilled Water: 2 inches, round.

2. Valve-Tag Colors:
a. Chilled Water: Black letters on brass background.

END OF SECTION 230553

HVAC PIPING INSULATION
23 07 19

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes insulating the following HVAC piping systems:

1. Chilled-water piping, indoors and outdoors.
2. Drain piping, indoors and outdoors.

B. Related Sections:
1. Section 232113.13 "Underground Hydronic Piping" for pipe insulation in underground piping outside the building.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory and field applied if any).

B. Insulation Schedule.

C. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
2. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
3. Detail removable insulation at piping specialties.
4. Detail application of field-applied jackets.
5. Detail application at linkages of control devices.

D. Samples: For each type of insulation and jacket indicated. Identify each Sample, describing product and intended use.
   1. Manufacturer's Color Charts: For products where color is specified, show the full range of colors available for each type of finish material.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer.

B. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.

C. Field quality-control reports.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.

B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.

   1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
   2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

B. Maintain ambient conditions required by manufacturer of tapes, adhesives, mastics, cements, and insulation materials.

C. Follow manufacturer’s recommended handling procedures.

D. Insulation Materials shall be protected from moisture and weather before and during installation.

E. Damaged or wet insulation materials or materials obtained from wet shipping boxes or containers will be removed from the job site and shall not be installed.

1.7 COORDINATION

A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."

B. Coordinate clearance requirements with piping Installer for piping insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

1.8 SCHEDULING

A. Schedule insulation application after pressure testing systems. Insulation application may begin on segments that have satisfactory test results.

B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

A. Comply with requirements in "Piping Insulation Schedule, General," "Indoor Piping Insulation Schedule," "Outdoor, Aboveground Piping Insulation Schedule," and "Outdoor, Underground Piping Insulation Schedule" articles for where insulating materials shall be applied.

B. Products shall not contain asbestos, lead, mercury, or mercury compounds.

C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C871.

D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C795.

E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

F. Cellular Glass: Inorganic, incombustible, foamed or cellulated glass with annealed, rigid, hermetically sealed cells. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

a. Pittsburgh Corning Corporation.

2. Block Insulation: ASTM C552, Type I.
3. Special-Shaped Insulation: ASTM C552, Type III.
4. Board Insulation: ASTM C552, Type IV.
5. Preformed Pipe Insulation without Jacket: Comply with ASTM C552, Type II, Class 1.
6. Preformed Pipe Insulation with Factory-Applied ASJ: Comply with ASTM C552, Type II, Class 2.
7. Factory fabricate shapes according to ASTM C450 and ASTM C585.

G. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C534, Type I for tubular materials.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Aeroflex USA, Inc.
b. Armacell LLC.
c. K-Flex USA.

2.2 THERMAL-HANGER SHIELD INSERTS

A. Prohibited: Wood block inserts.

B. Refer to Section 230529 “Hangers and Supports for HVAC Piping and Equipment” for requirements.

2.3 ADHESIVES

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.

B. Cellular-Glass Adhesive: Two-component, thermosetting urethane adhesive containing no flammable solvents, with a service temperature range of minus 100 to plus 200 deg F.

C. Flexible Elastomeric: Comply with MIL-A-24179A, Type II, Class I.

D. ASJ Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.

E. PVC Jacket Adhesive: Compatible with PVC jacket.

2.4 MASTICS AND COATINGS

A. Materials shall be compatible with insulation materials, jackets, and substrates.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Childers Brand; H. B. Fuller Construction Products.
    b. Foster Brand; H. B. Fuller Construction Products.

B. Vapor-Retarder Mastic: Water based; suitable for indoor use on below-ambient services.

1. Water-Vapor Permeance: Comply with ASTM C755, Section 7.2.2, Table 2, for insulation type and service conditions.
2. Service Temperature Range: Minus 20 to plus 180 deg F.
3. Comply with MIL-PRF-19565C, Type II, for permeance requirements.
4. Color: White.

C. Vapor-Retarder Mastic: Solvent based; suitable for indoor use on below-ambient services.

1. Water-Vapor Permeance: Comply with ASTM C755, Section 7.2.2, Table 2, for insulation type and service conditions.
2. Service Temperature Range: 0 to 180 deg F.
3. Color: White.

D. Vapor-Retarder Mastic: Solvent based; suitable for outdoor use on below-ambient services.

1. Water-Vapor Permeance: Comply with ASTM C755, Section 7.2.2, Table 2, for insulation type and service conditions.
2. Service Temperature Range: Minus 50 to plus 220 deg F.
3. Color: White.

2.5 LAGGING ADHESIVES

A. Description: Comply with MIL-A-3316C, Class I, Grade A and shall be compatible with insulation materials, jackets, and substrates.

1. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over pipe insulation.
2. Service Temperature Range: 0 to plus 180 deg F.
3. Color: White.

2.6 SEALANTS

A. Cellular-Glass:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Childers Brand; H. B. Fuller Construction Products.
b. Foster Brand; H. B. Fuller Construction Products.
c. Pittsburgh Corning Corporation.

B. Metal Jacket Flashing Sealants:

1. Materials shall be compatible with insulation materials, jackets, and substrates.
2. Fire- and water-resistant, flexible, elastomeric sealant.
3. Service Temperature Range: Minus 40 to plus 250 deg F.
4. Color: Aluminum.

C. ASJ Flashing Sealants and PVC Jacket Flashing Sealants:

1. Materials shall be compatible with insulation materials, jackets, and substrates.
2. Fire- and water-resistant, flexible, elastomeric sealant.
3. Service Temperature Range: Minus 40 to plus 250 deg F.
4. Color: White.

2.7 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:

1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C1136, Type I.

2.8 FIELD-APPLIED JACKETS

A. Field-applied jackets shall comply with ASTM C921, Type I, unless otherwise indicated.

B. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.

1. Adhesive: As recommended by jacket material manufacturer.
2. Color: White.
3. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.

    a. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.

C. Metal Jacket:

1. Stainless-Steel Jacket: ASTM A167 or ASTM A240/A240M.

    a. Sheet and roll stock ready for shop or field sizing.
    b. Material, finish, and thickness are indicated in field-applied jacket schedules.
    c. Moisture Barrier for Indoor Applications: 3-mil- thick, heat-bonded polyethylene and kraft paper.
    d. Moisture Barrier for Outdoor Applications: 2.5-mil- thick polysurlyn.
    e. Factory-Fabricated Fitting Covers:

        1) Same material, finish, and thickness as jacket.
        2) Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
        3) Tee covers.
        4) Flange and union covers.
        5) End caps.
        6) Beveled collars.
        7) Valve covers.
        8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

2.9 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C1136.

1. Width: 3 inches.
2. Thickness: 11.5 mils.
3. Adhesion: 90 ounces force/inch in width.
4. Elongation: 2 percent.
5. Tensile Strength: 40 lbf/inch in width.
6. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

B. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.

1. Width: 2 inches.
2. Thickness: 6 mils.
3. Adhesion: 64 ounces force/inch in width.
4. Elongation: 500 percent.
5. Tensile Strength: 18 lbf/inch in width.

C. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.

1. Width: 2 inches.
2. Thickness: 3.7 mils.
3. Adhesion: 100 ounces force/inch in width.
4. Elongation: 5 percent.
5. Tensile Strength: 34 lbf/inch in width.

2.10 SECUREMENTS

A. Bands:

1. Stainless Steel: ASTM A167 or ASTM A240/A240M, Type 304 or Type 316; 0.015 inch thick, 1/2 inch wide with wing seal.

B. Staples: Outward-clinching insulation staples, nominal 3/4-inch- wide, stainless steel or Monel.

PART 3 - EXECUTION

3.1 DELIVERY, STORAGE, AND HANDLING

A. Maintain ambient conditions required by manufacturer of tapes, adhesives, mastics, cements, and insulation materials.

B. Follow manufacturer’s recommended handling procedures.

C. Insulation Materials shall be protected from moisture and weather before and during installation. Wet insulation materials shall be discarded and shall be removed from the jobsite.

3.2 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.

1. Verify that systems to be insulated have been tested and are free of defects.
2. Verify that surfaces to be insulated are clean and dry.
3. Proceed with installation only after unsatisfactory conditions have been corrected.

3.3 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

B. Surface Preparation: Clean and prepare surfaces to be insulated. Before insulating, apply a corrosion coating to insulated surfaces as follows:
1. Carbon Steel: Coating for carbon steel piping is specified in Section 23 00 00 "Mechanical General Provisions".

C. Insulation shall not be installed until after all field welds are completed and all piping systems have been leak-tested and proven tight with no leaks.

D. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.

E. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.4 GENERAL INSTALLATION REQUIREMENTS

A. The design requirements of this specification are general and where it is not specific, pipe insulation, pipe fitting, flange and valve insulation and curved segments shall be fabricated by an approve applicator in compliance with ASTM C450 and ASTM C585.

B. Prior to installation of insulation material, its thickness shall be verified in accordance with the operating temperature and diameter of pipe or equipment as scheduled. If the thickness or type do not correspond, the insulation subcontractor shall contact the Construction Manager to resolve the conflict. The insulation subcontractor shall not, in

any case, establish a new thickness or select a different material type than that scheduled without written approval.

C. All insulation materials shall be installed in strict accordance with the manufacturer's recommendations, building codes, and industry standards. Manufacturer's recommendations shall be adhered to in application and handling all safety requirements for the materials.

D. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping including fittings, valves, and specialties.

E. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of pipe system as specified in insulation system schedules.

F. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

G. Install insulation with longitudinal seams at top and bottom of horizontal runs.

H. Install multiple layers of insulation with longitudinal and end seams staggered.

I. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

J. Keep insulation materials dry during application and finishing.

K. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

L. Install insulation with least number of joints practical.

M. Insulation pipe support inserts shall be provided for each pipe support.

1. Inserts will not be required on piping NPS 2-1/2 and smaller.
2. Inserts shall be the same insulation wall thickness as the adjoining standard insulation that is scheduled for the service.
3. Inserts shall be centered on the pipe support. This may require additional circumferential joints in the insulation.
4. The weight bearing characteristics of the pipe support shall be calculated as follows:

    a. Determine maximum pipe span.
    b. Calculate the weight of the pipe, contents (water or steam), and the insulation that will rest on the support.

c. The bearing area shall be 50% of the pipe OD (accounts for bearing on only the lower 60 degrees of the shield) multiplied by the length of the shield. Note, the insulation shield length will be based on the insulation OD, not the pipe OD.
d. Bearing stress shall be calculated load divided by the bearing area.
e. The bearing stress shall be less than 20% of the compressive strength of the insulation (Safety factor of 5.0).
f. If the insulation insert is over-stressed, consider reducing the supported span or use a MSS Type 39 protection saddle or shoe.

5. Coordinate the insulation pipe support insert lengths with the piping installer who is providing the MSS Type 40 insulation shields. Refer to Section 230529 "Hangers and Supports for HVAC Piping and Equipment."

N. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

1. Install insulation continuously through hangers and around anchor attachments.
2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

O. Where vapor barrier is indicated, the insulation shall be installed with a continuous unbroken and non-punctured factory-applied vapor barrier. The installation shall include vapor blocks at every fourth section and at every tee, elbow, or valve.

P. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

Q. Install insulation with factory-applied jackets as follows:

1. Draw jacket tight and smooth.
2. Cover circumferential joints with 3-inch- wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-

sealing lap. Staple laps with outward clinching staples along edge at 4 inches o.c.

a. For below-ambient services, apply vapor-barrier mastic over staples.

4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.

R. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

S. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

T. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

3.5 PENETRATIONS

A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.

1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
4. Seal jacket to roof flashing with flashing sealant.

B. Insulation Installation at Underground Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.

C. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.

1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor

insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.

3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
4. Seal jacket to wall flashing with flashing sealant.

D. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

E. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions. Maintain rating of fire-rated wall and partition assembly.

F. Insulation Installation at Floor Penetrations:

1. Pipe: Install insulation continuously through floor penetrations.
2. Seal penetrations through fire-rated assemblies.

3.6 GENERAL PIPE INSULATION INSTALLATION

A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.

B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:

1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.

5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.
6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
7. Provide vapor stops at each valve, elbow, and tee and at every fourth section of insulation on below ambient temperature piping.
8. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
9. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
10. Stencil or label the outside insulation jacket of each union with the word "union." Match size and color of pipe labels.
11. All vapor barriers shall be continuous. Following the installation of vapor blocks on piping, re-establish the continuous vapor block by overlapping the valve or fitting insulation vapor retarder with the adjacent piping vapor retarder using mastic or tape.
12. All jacketing materials shall be sealed tight to avoid the intrusion of water and moisture. Where valves or fittings are encountered, overlap the PVC or metal jacketing, and seal the joint.

C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

D. Install removable insulation covers at locations indicated. Installation shall conform to the following:

1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness

over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.

3. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.
4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

3.7 INSTALLATION OF CELLULAR-GLASS INSULATION

A. General Installation Requirements:

1. Secure single-layer insulation with stainless-steel bands at 12-inch intervals and tighten bands without deforming insulation materials.
2. Apply joint sealant on all longitudinal seams (2 per section) and on all circumferential joints of pipe sections and prefabricated fitting covers.
3. On vertical run piping, install insulation support rings at the base of each riser, just above the elbow or tee, and at 15-foot intervals. Coordinate requirements with the piping installer.

B. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above-ambient services, secure laps with outward-clinched staples at 6 inches o.c.
4. For insulation with factory-applied jackets on below-ambient services, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.
5. Apply underground jacketing material to the pipe. Provide vapor stop at these ends of insulation.
6. Provide vapor stops after every fifth section of the pipe insulation for below ambient applications.

C. Insulation Installation on Pipe Flanges:

1. Provide vapor stops at the ends of the pipe insulation adjacent to the flange for below ambient applications.
2. Provide bell holes in the ditch that will permit the insulation of the flanges and bells.
3. Install preformed pipe insulation to outer diameter of pipe flange.
4. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
5. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of cellular-glass block insulation of same thickness as pipe insulation or with foamed -in-place polyurethane.
6. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.
7. Apply underground jacketing material to the pipe. Provide a minimum overlap of the underground jacketing material of 6-inches beyond the end of the insulation on the adjacent pipe section.

D. Insulation Installation on Pipe Fittings and Elbows:

1. Provide vapor stops at the ends of the pipe insulation adjacent to the pipe fitting or elbow for below ambient applications.
2. Provide bell holes in the ditch that will permit the insulation of the pipe fittings and elbows.
3. Install preformed sections of same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
4. When preformed sections of insulation are not available, install mitered sections of cellular-glass insulation. Secure insulation materials with wire or bands.
5. Apply underground jacketing material to the pipe. Provide a minimum overlap of the underground jacketing material of 6-inches beyond the end of the insulation on the adjacent pipe section.

E. Insulation Installation on Valves and Pipe Specialties:

1. Provide vapor stops at the ends of the pipe insulation adjacent to the valve or pipe specialty for below ambient applications.
2. Install preformed sections of cellular-glass insulation to valve body.
3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
4. Install insulation to flanges as specified for flange insulation application.
5. Fill voids between inner circumference of valve or pipe specialty insulation and outer circumference of the valve or pipe specialty with foamed -in-place polyurethane.

6. Apply PVC or stainless-steel jacket as specified.

3.8 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

B. Insulation Installation on Pipe Flanges:

1. Install pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.
4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install mitered sections of pipe insulation.
2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed valve covers manufactured of same material as pipe insulation when available.
2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.
4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.9 FIELD-APPLIED JACKET INSTALLATION

A. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications. Seal with manufacturer's recommended adhesive.

1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

B. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.

3.10 FINISHES

A. Pipe Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below.

1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.

a. Finish Coat Material: Interior, flat, latex-emulsion size.

B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.

C. Color: Follow Owner’s standard color scheme:

1. Chilled Water Supply: Cobalt Stone (PPG1241-7)
2. Chilled Water Return: Windsor Way (PPG1239-3)

D. Vary first and second coats to allow visual inspection of the completed Work.

E. Do not field paint aluminum or stainless-steel jackets.

3.11 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:

1. Inspect pipe, fittings, strainers, and valves, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to three locations of straight pipe, three locations of threaded fittings, three locations of welded fittings, and three locations of flanged valves for each pipe service defined in the "Piping Insulation Schedule, General" Article.

C. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.12 PIPING INSULATION SCHEDULE, GENERAL

A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.

3.13 INDOOR PIPING INSULATION SCHEDULE

A. Drain piping below 60 Deg F:

1. All Pipe Sizes: Insulation shall be one of the following:
   a. Flexible Elastomeric: 1 inch thick.

B. Chilled Water:

1. NPS 3 and Smaller: Insulation shall be one of the following:

   a. Cellular Glass: 1-1/2 inches thick.

2. NPS 4 to NPS 6: Insulation shall be one of the following:

   a. Cellular Glass: 1-1/2 inches thick.

3. NPS 8 and Larger: Insulation shall be one of the following:

   a. Cellular Glass: 2 inches thick.

3.14 OUTDOOR, ABOVEGROUND PIPING INSULATION SCHEDULE

A. Chilled Water:

1. All Pipe Sizes: Insulation shall be one of the following:

   a. Cellular Glass: 2 inches thick.

3.15 OUTDOOR, UNDERGROUND PIPING INSULATION SCHEDULE

A. Insulation for underground piping is specified in Section 232113.13 "Underground Hydronic Piping".

3.16 INDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Piping, Exposed:
1. PVC: 30 mils thick.

3.17 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Piping, Exposed:
1. Stainless Steel, Type 304 or 316, Stucco Embossed with Z-Shaped Locking Seam: 0.020 inch thick.

3.18 UNDERGROUND, FIELD-INSTALLED INSULATION JACKET

A. Insulation jacket for underground piping is specified in Section 232113.13 "Underground Hydronic Piping".

END OF SECTION 230719

INSTRUMENTATION & CONTROLS SYSTEM
23 09 00

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Furnish, install, and test process instruments, transmitters and local gauges for monitoring and indicating flow, level, pressure, and temperature. Provide devices as described within the specifications and as indicated on the Piping and Instrumentation Diagrams (P&ID's).

B. Furnish, install, and test control valves, actuators and regulators.

C. The Contractor shall provide materials, equipment, labor, and other incidental items necessary to provide a complete and functional system regardless of any materials or equipment not listed in this specification.

1.2 RELATED SECTIONS

A. 230519 Meters and Gauges for HVAC Piping.

B. 260519 Low-Voltage Electrical Power Conductors and Cables.

C. 260533 Raceway and Boxes for Electrical Systems.

1.3 SUBMITTALS

A. Submittals: Provide the following information after receipt of order:

1. Product Data: Data sheets shall be clearly marked to reflect actual product and options furnished.

    a. Submit fully populated data sheets for instruments and control valves per ISA 20 format (or design professional approved format).
    b. Submit the following for each instrument furnished:

        1) Manufacturers' data indicating use, operating range, accuracy, and location for manufactured components.
        2) Product description, model, dimensions, component sizes, rough-in requirements, service sizes, and finishes.
        3) Schedule indicating P&ID instrument tag and P&ID drawing number with instruments manufacturer, model number, size, location, rated capacity, loads served, and accessories for each instrument.
        4) Electrical characteristics and connection requirements.
        5) Installation data including mechanical, electrical and programming data in Adobe Acrobat (PDF) format.

2. Submit the following information for each valve and actuator furnished:

    a. Valve tag and specific application in plant expressed in terms of service and contract P&ID drawing number where shown.
    b. Description including type of valve, type of operator, and accessories.
    c. Outline dimensions, weights, size and type of end connections.
    d. Maximum working pressures, inlet, outlet, and shutoff, for which valve is designed.
    e. Materials of construction and coatings for valves and accessories.
    f. Valve sizing calculations are based on ISA 75.01.01 sizing formulas.
    g. Installation data including mechanical, electrical and programming data in PDF format.

3. Drawings:

    a. Submit installation details for each type of device showing mounting, tubing, manifolds, isolation valves, bill of materials. Include weights, mounting and lifting details for valves and actuator assemblies.
    b. Submit nameplate and legend engraving lists.
    c. Submit communications segment drawings for networked devices.
    d. Provide as-built piping drawings to show final-installed location and configuration of valves and instrumentation.

4. Special Tools: Furnish one set of special tools, calibration devices, or specific test instruments required for operation, calibration, and maintenance of each type of device provided under this section.
5. Spare Parts: Provide a recommended spare parts list.
6. Schedule:

    a. Maintain an expediting and delivery schedule for all valves and instruments.
    b. Track submittals and product delivery, update schedule weekly.
    c. Provide schedule for field checkout and calibration of instruments and control valves.

7. Manufacturer's certificate: Certify that products meet or exceed specified requirements.
8. Records: Furnish field quality control installation inspection report with the following records/reports for the instruments and control valves:

    a. Factory calibration and test reports.
    b. Field checkout/calibration data.
    c. Instrument loop checks.

B. Operations and Maintenance Manuals: Submit O&M manuals for equipment provided. Include a table of contents, manufacturer's information of equipment and function, listing of supplier contract information (name, address, and telephone), theory of operation, operation procedures, instructions for calibrating instruments, installation

instructions, assembly views, lubrication, troubleshooting and repair procedures, preventative maintenance schedule, warranties, replacement parts, and recommended spare parts list.

1.4 QUALITY ASSURANCE

A. The design, equipment, material and installation of the Work shall conform to requirements of the latest edition of the following codes and standards:

1. National Electrical Code (NEPA 70 with State amendments)
2. National Electric Manufacturers Association (NEMA)
3. American National Standard Institute (ANSI)
4. Institute of Electrical and Electronics Engineers (IEEE)
5. International Society of Automation (ISA)
6. UL Rated Components.

B. Installer Qualifications: Company specializing in performing Work of this Section with minimum five years documented experience, and approved by manufacturer.

C. Field Testing/Calibration Qualifications: Test personnel shall have a minimum of ten years documented experience with testing of the system equipment.

D. Provide services of qualified technicians to support start-up and commissioning of field instrumentation and valves.

1.5 WARRANTY

A. Furnish manufacturer's warranty for items supplied under this Section; minimum of one year warranty for parts and labor.

PART 2 - PRODUCTS

2.1 GENERAL

A. Provide 16 gauge stainless steel tags 1 inch x 2 inch or larger for all field instrumentation and valves engraved with the instrument tag number as indicated on the device data sheet. Tags are to be affixed to devices with ether stainless steel cable or screws.

B. All instruments and equipment provided and installed by the Contractor shall be new and free from defects.

C. Field devices shall be rated for use in designated area classification.

2.2 INSTRUMENTATION

A. Contractor to select instrumentation based on process data contained within the contract documentation.

B. Provide instruments, valves and associated equipment rated as to provide a 30-year installed equipment life.

C. Provide same manufacturer's equipment for similar type installations, i.e., pressure transmitters shall be supplied from one manufacturer.

D. Provide instruments including pipe, tubing, manual valves, supports, pipe and tube fittings, wire/cable, conduit, tray, terminations, racks, mounting stands, mounting plates, and other accessories as needed to complete a working and operable instrumentation and control system.

E. Provide local process gauges with dial sizes between 3 to 5 inches in diameter unless location is further away than 3 feet when 6 to 8 inch or larger gauges will be required, as read from the operating floor.

F. Provide analog process gauge scales so that the expected normal operating value is approximately 1/3 to 2/3 of full-scale range. Working pressure in all cases shall be limited to 75 percent of full-scale range.

G. Provide transmitters so that the maximum expected process value is approximately 80-90 percent of the calibrated range.

H. Provide remote sensing electronics for transmitters with local indication as noted on the drawings, mount at a location away from heat sources and accessible by plant operators as close as possible to sensing point.

I. Provide transmitters with integral display units, as marked on drawings.

J. Provide transmitters with required environmental ratings for service duty, for process and location (indoor or outdoor) temperature and pressure ratings.

2.3 VALVES AND ACUTATORS

A. Electric Motors: Size to operate with sufficient reserve power to provide smooth modulating action or two-position action.

B. Electronic Actuators: Direct-coupled type designed for minimum 60,000 full-stroke cycles at rated torque.

C. Valve Actuators

1. Basis-of-Design Product: Subject to compliance with requirements, provide Belimo Aircontrols (USA), Inc. or comparable product by one of the following:

a. Rotork
b. Valve manufacturer's standard offering
c. Approved Equal.

2. Valves: Size for torque required for valve close off at maximum pump differential pressure.

a. Non-spring-Return Motors for Large Control Valves: Size for 150 percent of running torque requirement and 200% of breakaway torque requirement.
b. Non-spring-Return Motors for Small Control Valves less than NPS 2-1/2: Size for running torque of 150 inch-lbf and breakaway torque of 300 inch-lbf.
c. Spring-Return Motors for Small Valves less than NPS 2-1/2: Size for running and breakaway torque of 150 inch-lbf.
d. Each valve actuator shall include a clutch and hand wheel operator that will permit the valve to be manually positioned in the event of an actuator failure.
e. Each actuator shall include a visual position indicator.
f. The valve actuators shall operate on 120 volt-1-phase power.
g. Refer to control valve article for additional requirements.

D. Central Utility Plant Valve Actuators:

1. Manufacturers:

a. Auma
b. EIM Valve Controls
c. Limitorque
d. Rotork
e. Triac
f. Bettis
g. Bray

2. Equipment:

a. Enclosure: NEMA 4X.
b. Operator: Include the motor, controller (for modulating service), power gearing, limit switch gearing, limit switches adjustable torque switches, heaters, local mechanical position indication, motor brake, stem nut, auxiliary handwheel, drain holes with threaded plugs, switch housings and floor stand if required, all as a self-contained unit.
c. Operation: The operator shall develop 200 percent of the required unseating torque and 150 percent of the required running torque under actual operating conditions. Operating conditions shall take into consideration the pressure differential across the valve and shutoff head.
d. Modulating Command Signal: 4-20mA.

e. Action on Loss of Command Signal: Remain last position (fail last position).
f. Gears: Motor speed reduction by hardened steel spur gears and self-locking worm gear. Quarter turn valves shall have a gearhead with adjustable mechanical stops internally located that can withstand full torque requirements of the valve in both open and closed positions.
g. Rotating Components: Gearing and shaft supported on anti-friction bearings; thrust component supported on tapered roller bearings.
h. Lost Motion Device: Operators on open-close service shall have a built-in lost motion device to permit motor to attain full speed before load is encountered, thus permitting a hammer-blow to be imparted to start valve in motion in either the closing or opening direction.
i. Manual Override: Local HOA switch mounted 48 inches above FFL and manual clutch with handwheel.
j. Conduit Entry: 1/2 NPT.
k. Motors:

    1) NEMA 4, 6, or 7 as required and Class F insulation with thermal overload.
    2) Motors shall have a duty rating of not less than 15 minutes and shall be capable of operating the valve through 2 cycles against full unbalance pressure without exceeding the permissible temperature rise specified.
    3) Motors shall be suitable for operation of valve under maximum differential pressure with standard deviations of voltage and frequency as defined by NEMA.
    4) Power: 120VAC for all valve sizes.

l. Position Indication: Local and to the BAS. Open/close for isolation valves using limit switches. Modulating valve with 4-20ma position transmitters for 0 to 100 percent open indication.
m. Torque Switches:

    1) Valve operators shall be equipped with two adjustable torque switches, one for protection in the opening direction, the other for control seating the valve.
    2) Torque switches shall be responsive to load encountered in opening or closing direction and shall be adjustable to desired operating characteristics to permit protection should an obstruction be met in either direction of valve travel.
    3) Closing torque switch shall be employed to control predetermined seating thrust. Travel and thrust shall be independent of wear in disk or seat rings.
n. Limit Switches:

    1) Limit switches shall be an integral part of the valve operator. They shall be of the adjustable type capable of being set to trip at any point

between fully open and fully closed. Limit switch gearing shall be of the intermediate type of stainless steel or high tensile bronze. Gears shall be grease lubricated. Valve operators shall be provided with geared limit switches as required.

2) Limit switches shall be geared to driving mechanism and in step at all times whether in power operation or manual operation.

o. Switch Housing:

1) Limit switches and torque switches shall be housed in an enclosure integral with power compartment of valve control. Push buttons, hand-off-auto switches, and indicating lights shall be corrosion resistant, and watertight.
2) A terminal strip shall be provided in the switch compartment. Controls and switch compartments shall be shop wired to a terminal strip complete and ready for field installation. At least 4 spare terminals shall be supplied.
3) For power and control conduits to the operator, there shall be two conduit openings, one for power and one for control.
4) Space heaters shall be provided in the switch and motor compartments of wattage suitable for keeping the compartments dry at all times. There shall be installed suitable breather and drain holes plugged with threaded plugs.
5) A schematic wiring diagram shall be permanently attached and protected from the environment, for maintenance use.

E. Large Control Valves

1. This specification pertains to control valves that require a CV greater than 500 gpm per psid water.
2. The valves provided for the chilled water and heating hot water systems shall meet the requirements of Section 230523, “General Duty Valves for HVAC Piping.”

a. Body Style: Lug.
b. Actuator Sizing: Size all actuators for 65 psig shut-off differential pressure.

3. The valves shall include an electric motor operated actuators provided by their respective valve manufacturers or by Belimo, Rotork, or approved equal.

F. Small Control Valves

1. This specification pertains to control valves that are required to have a Cv of 500 gpm per psid water or less.

a. Basis-of-Design Product: Subject to compliance with requirements, provide Belimo Aircontrols (USA), Inc. or comparable product by one of the following:

1) Approved Equal.

2. Control Valves: Factory fabricated, of type, body material, and pressure class based on maximum pressure and temperature rating of piping system, unless otherwise indicated.

   a. Valves requiring a Cv of 500 or smaller shall be globe valves. Valves requiring a Cv larger than 500 shall be butterfly valves.

3. Hydronic system globe valves used in modulating service shall have the following characteristics:

   a. NPS 2 and Smaller: Class 125 bronze body, bronze trim, rising stem, renewable composition disc, and screwed ends with backseating capacity repackable under pressure.
   b. NPS 2-1/2 and Larger: Class 125 iron body, bronze trim, rising stem, plug-type disc, flanged ends, and renewable seat and disc.
   c. Internal Construction: Replaceable plugs and stainless-steel or brass seats.

      1) Single-Seated Valves: Cage trim provides seating and guiding surfaces for plug on top and bottom.

   d. Valves may also be V-port ball valves.
   e. Sizing: 5-psig maximum pressure drop at design flow rate or the following:

      1) Two Position: Line size.
      2) Two-Way Modulating: Either the value specified above or twice the load pressure drop, whichever is more.
      3) Three-Way Modulating: Twice the load pressure drop, but not more than value specified above.

   f. Flow Characteristics: Two-way valves shall have equal percentage characteristics; three-way valves shall have linear characteristics.
   g. Close-Off (Differential) Pressure Rating: Combination of actuator and trim shall provide minimum close-off pressure rating of 150 percent of total system (pump) head for two-way valves and 100 percent of pressure differential across valve or 100 percent of total system (pump) head.

2.4 INSTRUMENT VALVES

A. Manufacturers:

1. Anderson Greenwood
2. Rosemount
3. Swagelok
4. Parker

B. Provide instrument valves for isolation and calibration as shown on instrumentation detail Drawings.

C. Instrument valve manifolds shall be preferred over individual valves:

1. 2-Way Manifold: Absolute or gauge pressure instruments.
2. 3-Way Manifold: Differential pressure instruments.

2.5 LIQUID INSTRUMENTS

A. General:

1. Provide same manufacturer's equipment for similar type installations, i.e., pressure transmitters shall be supplied from one manufacturer.
2. Provide local process gauges with dial sizes between 3 to 5 inches in diameter unless location is further away than 3 feet when 6 to 8 inches or larger gauges will be required, as read from the operating floor. Connections are ½ NPT.
3. Provide analog process gauge scales so that the expected normal operating value is approximately 1/3 to 2/3 of full-scale range. Working pressure in all cases shall be limited to 75 percent of full-scale range.
4. Provide transmitters so that the maximum expected process value is approximately 80-90 percent of the calibrated range.
5. Provide remote sensing electronics for transmitters with local indication if needed to mount at a location accessible by plant operators as close as possible to sensing point.
6. Provide transmitters with required environmental ratings for service duty, for process and location (indoor or outdoor) temperature and pressure ratings.
7. Provide transmitters with integral display units, as marked on drawings.
8. Provide process instruments with wetted parts that are compatible with the intended service.

B. Flowmeters:

1. Flowmeter operating principle application is dependent on process fluid and physical piping configuration requirements, minimum number of upstream and downstream pipe diameter straight run.
2. Magnetic Flowmeter

    a. Manufacturers:

        1) Rosemount
        2) Endress & Hauser
        3) Toshiba.
        4) ABB

    b. Application: Liquid Flow.
    c. Flowtube:

1) Bi-directional
2) Flow Range: 0.04 and 40 ft/s
3) Accuracy: 0.25 percent
4) Process Temperature Range: –30 to 185 degrees F
5) Pressure: ASME B16.5 (ANSI) Class 150
6) Materials:

    a) Lining: Neoprene
    b) Tube: Stainless Steel Type 304
    c) Flanges: Stainless Steel Type 304
    d) Housing: Welded Steel
    e) Electrodes: Stainless Steel Type 316L
    f) Coating: Epoxy Resin/Polyurethane

7) Electrical Connections: 1/2 inch NPT
8) Protection: NEMA 4

d. Flow Transmitter:

1) Flow Range: Variable
2) Power Supply: 24VDC with surge protection
3) Ambient Temperature: 0-140F
4) Ambient Humidity: 0-100 percent RH
5) Analog Output: 4-20mA dc,
6) Local Display: LCD or LED

C. Pressure Gauges:

1. Manufacturer:

    a. Ashcroft
    b. Weksler Instruments
    c. Wika Instrument Corporation

2. Applications: Liquid fluids, chemical treatment, air or steam.
3. Gauge: ASME B40.1 with bourdon tube, rotary brass movement, brass socket, front calibration adjustment, black scale on white background.
4. Range: Variable
5. Case: Phenolic
6. Window: Safety Glass
7. Bourdon Tube: Stainless Steel
8. Dial Size: 4.5 inches diameter, white
9. Pointer: Black aluminum, adjustable
10. Accuracy: 0.5 percent full scale range
11. Scale: Pounds per square inch
12. Connection: 1/2-inch NPT
13. Gauge Accessories:

a. Snubbers: 316 stainless steel, to protect against pressure surges and shocks.
b. Siphon: 316 stainless steel, to protect against live steam applications.
c. Protection: Overload stop or blowout back.
d. Liquid Fill: Silicone Oil.

D. Differential Pressure Gauge:

1. Manufacturer:

a. Ashcroft
b. H.O. Trerice Company
c. Weksler Instruments
d. Wika Instrument Corporation

2. Applications: Liquid fluids, chemical treatment, air, or steam.
3. Equipment:

a. Range: Variable
b. Case: Phenolic
c. Window: Safety Glass
d. Bourdon Tube: Phosphor Bronze or Stainless Steel dependent on process liquid.
e. Dial Size: 4.5 inches diameter, white.
f. Pointer: Black aluminum, adjustable, zero at seven o'clock position.
g. Accuracy: Grade A (2-1-2%)
h. Scale: PSID
i. Connection: 1/2-inch NPT
j. Gauge Accessories:

1) Snubbers: 316 stainless steel, to protect against pressure surges and shocks.
2) Siphon: 316 stainless steel, to protect against live steam applications.
3) Protection: Overload stop or blowout back.
4) Liquid Fill: Silicone Oil

E. Pressure Transmitters (Absolute, Gauge, or Differential):

1. Manufacturer:

a. ABB
b. Foxboro
c. Rosemount
d. Endress & Hauser
e. Yokogawa

2. Application: Liquid fluids, chemical treatment, air, or steam.

3. Equipment:

    a. Range: Variable
    b. Type: Electronic, Isolating diaphragm
    c. Indicator: Local, 4 digit LCD
    d. Electronics Housing: NEMA 4X
    e. Diaphragm: Stainless Steel
    f. Wetted O-Rings: Viton
    g. Cover O-Rings: Buna-N
    h. Drain & Vent: Side connection
    i. Process Connection: 1/2-inch NPT
    j. Electrical Connection: 1/2-inch NPT
    k. Output: 4-20mA dc,
    l. Failure Mode: Jumper selectable, set for fail low
    m. Power Supply: 2 wire 24VDC loop powered
    n. Accuracy: 0.25 percent of span
    o. Mounting Bracket: U-bolt for 2 inch pipe; carbon steel, coated with polyurethane paint.

F. Temperature Gauge:

1. Manufacturers:

    a. Ashcroft
    b. H.O. Trerice Company
    c. Palmer-Wahl Instruments, Inc.
    d. Weksler Instruments
    e. Wika Instrument Corporation
    f. Ametec

2. Application: Liquid fluids, Saturated Steam, Air
3. Thermometer: ASTM E 1, ASTM E 77, and ASME B40.3 stainless steel case, bimetallic helix actuated with silicone fluid damping, white with black markings and black pointer hermetically sealed lens, stainless steel stem.

    a. Range: Variable
    b. Lens: Shatterproof glass
    c. Dial Size: 3 to 5 inches diameter, white
    d. Pointer: Black aluminum, adjustable
    e. Stem: 304SS, 1/4-inch diameter, welded at tip and case connector
    f. Process Connection: 1/2-inch MNPT, all multi-angle swivel connection.
    g. Seal: Hermetic per ASME B40.3.
    h. Accuracy: 1 percent
    i. Calibration: Degrees F
    j. Over Range: Temporary over or under range of 50 percent of scale not to affect accuracy.

G. Temperature Elements (RTD - for thermowell mounting):

1. Manufacturer:

   a. Conax
   b. Moore Industries, Inc.
   c. Foxboro
   d. Rosemount
   e. JMS
   f. ABB
   g. Endress & Hauser
   h. Yokogawa

2. Application: Liquid fluids, Steam, Air.
3. Equipment:

   a. Type: 100 ohm Platinum, 3-wire
   b. Element: Single or dual element, with epoxy moisture seal, spring-loaded.
   c. Sheath Diameter: 0.25 inches
   d. Sheath Material: Stainless Steel
   e. Insulation Fill: MgO or Al_2O_3
   f. Temperature Range: Variable
   g. Sensor Length: Variable
   h. Temperature Coefficient of Resistance: 0.003850 ohm/ohm/degree C, plus or minus 0.1 degree F interchangeability
   i. Differential Temperature: Matched pair RTDs
   j. Connection Head: 316 stainless steel with gasket, NEMA 4 rating, 1/2-inch MNPT instrument and 1/2-inch FNPT conduit

H. Thermowell (RTD and Bi-Metallic Temperature Gauge):

1. Manufacturer: (Note: Thermowell to be ordered from same manufacturer of associated device as a set).
2. Application: Liquid fluids, Steam
3. Equipment:

   a. Temperature Range: Variable
   b. Type: Tapered Shank.
   c. Bore Diameter: 0.26 inches (for 0.25 in RTD)
   d. Mounting: Socket-Weld
   e. Material: 316 stainless steel
   f. Service Rating: 2000 psi at 800 degrees F
   g. Insertion Length: Variable
   h. Instrument Connection: 1/2-inch FNPT
   i. Provide wake frequency calculation on thermowells per ASME PTC 19.3.

I. Temperature Transmitter:

1. Manufacturer:

    a. Moore Industries, Inc.
    b. Foxboro
    c. Rosemount
    d. Endress & Hauser
    e. Yokogawa

2. Application: Liquid fluids, Saturated Steam
3. Equipment:

    a. Type: 3-wire, 100 ohm RTD
    b. Electronics Housing: NEMA 4X
    c. Housing Material: Stainless steel
    d. Output: 4-20mA dc,
    e. Failure Mode: Jumper selectable, set for fail low
    f. Power Supply: 2 wire loop 24VDC loop powered
    g. Accuracy: 0.25 percent of span
    h. Temperature Range: Variable
    i. Connections: Screw terminals.

2.6 CONTROL PANELS

A. Manufacturers:

1. Hammond Manufacturing Company, Inc.
2. Hoffman Engineering Company.
3. Rittal Corporation.
4. Saginaw Control & Engineering
5. Kele

B. Construction:

1. Provide wall mounted, floor mounted or free standing, UL rated, NEMA 1 gasketed, rolled steel cabinets to house local/remote controls and indicators, PLC control units and associated equipment located indoors.
2. Portions of the control system that already include NEMA 1 enclosures are not required to be housed in additional enclosures outlined in this section.
3. Local control panels shall be located in close proximity to the associated plant equipment.
4. Provide a rigid minimum heavy gauge mild steel structural frame, panel supports, seams continuously welded and ground smooth.
5. Provide back-mounting panel for computer, fuses, relays, terminal strips, raceway and accessory mounting.
6. Provide stainless steel hinge pin with heavy-duty continuous door hinge.
7. Provide grounding stud on door and body.
8. Provide environmental controls for electronic equipment as required.

9. Provide the following panel accessories:

    a. Door stop kit to secure door in open position (for floor mounted units).
    b. Metal data pocket to provide place to store documentation inside the panel.
    c. Keylock handles (for floor mounted units).

C. Electrical:

1. Provide panel fused disconnect switch or circuit breaker.
2. Provide power strips that meet the following requirements:

    a. Rating: 15 amps - 125VAC.
    b. EMI/RFI Attenuation: Minus 5 decibels to minus 40 decibels at 100 kHz to 30 mHz.
    c. Surge Protection: Metal Oxide Varistor.
    d. Clamping Voltage: 400V.
    e. UL 1449 tested.

3. Provide internal cabling management system for the routing and protection of wiring.
4. Provide numbered terminal strips for all externally connected devices. Limit external wire attachments to one wire per terminal. Provide 20% additional terminals.
5. Provide grounding bar system with tapped holes.

2.7 MISCELLANEOUS

A. Relays

1. Manufacturers:
    a. Cutler Hammer.
    b. General Electric.
    c. IDEC
    d. Kele

2. Application: Conversion of low voltage digital output signals from the control system or another system power source to 24 volt and 120-volt heavy-duty on-off signals required by motor operated equipment, indicating light and alarm signals.
3. Input Voltage: Compatible with Control System, or input power.
4. Output Capacity: Rated for Current required by user at rated voltage.
5. Modifications: Delay on make, delay on break, and timer functions may be included in addition to on-off if required by the application.

B. Control Switches and Indicating (Pilot Lights):

1. Manufacturers:
    a. Cutler Hammer.
    b. General Electric.

2. Application: Local panel indication.
3. Indicating/Pilot Lights:

    a. Type: Heavy duty, oil tight, UL listed.
    b. Lamp: Incandescent or LED, push-to-test.
    c. Size: 1 inch nominal.
    d. Lens Color: Variable (red, green, amber, blue, clear, white).
    e. Lens Material: Polycarbonate.
    f. Ingress Protection: IP 65, NEMA 4.
    g. Operating Conditions: 0 to 120 deg F, and 0 to 95 percent RH non-condensing.
    h. Legend Plate: Engraved as directed by Owner.

4. Control Switches:

    a. Type: Heavy duty, oil tight, UL listed, 2 or 3 position selector switch or pushbutton switch.
    b. Position Switch Handle: Knob or lever, with positive position indication.
    c. Color: Black.
    d. Action: Maintained for toggle switches and momentary contact for pushbuttons.
    e. Contact Material: Gold.
    f. Contact Operation: Slow make and break.
    g. Mechanical Life: Greater than 1 million operations.
    h. Vibration Resistance: 10G at 10 to 2,000 hertz, displacement 1 mm.
    i. Shock Resistance: Greater than 15G at 11 msec.
    j. Electrical Ratings:

        1) AC: 250V/10A.
        2) DC: 24V/6A.

    k. Ingress Protection: IP 65, NEMA 4.
    l. Operating Conditions: 0 to 120 degrees F, 0 to 95 percent RH non-condensing.
    m. Legend Plate: Engraved as directed by Owner.

PART 3 - EXECUTION

3.1 GENERAL

A. Contractor shall have the overall responsibility for the installation, commissioning, successful operation and performance of all the instrumentation and performance of all the instrumentation and control systems referred to herein.

B. Provide and install all instrumentation tubing, fitting and special wire necessary to install the instrumentation system.

C. Perform testing of field instrumentation and support the testing of the overall instrumentation and control systems.

D. All control equipment shall be fully modulating unless otherwise noted, and relays or accessories not specifically mentioned but required for proper operation shall be included.

E. Flow meters are to be selected based on installation conditions and are to include the proper upstream and downstream straight dimensions. Heads are to be mounted in the proper orientation to minimize sensing errors.

F. All controls shall operate satisfactorily without any cycling or hunting.

G. The Contractor shall provide power to all electric actuators requiring an external power source. Coordinate with Division 26 requirements.

3.2 DELIVERY, STORAGE, AND HANDLING

A. Contractor shall provide the services of an expeditor to track submittals, promised delivery, and final delivery of all valves and instruments. Tracking schedule shall be updated weekly.

B. All instruments shall be tagged with instrument number prior to commissioning.

3.3 EXAMINATION

A. Verify that areas and conditions where equipment is to be installed are satisfactory to proceed with work activities.

B. Verify installations against the piping and instrument diagram and installation details.

C. Visually inspect installation for damage. If damage is observed, it shall be recorded and corrective action taken.

D. The contractor shall thoroughly examine the project plans for control device and equipment locations, and any discrepancies, conflicts, or omissions shall be reported to the Architect for resolution before rough-in work is started.

E. The contractor shall inspect the site to verify that equipment is installable as shown, and any discrepancies, conflicts, or omissions shall be reported to the Architect for resolution before rough-in work is started.

F. The contractor shall examine the drawings and specifications and if head room or space conditions appear inadequate or if any discrepancies occur between the plans for work under this contract and the plans for the work of others, the discrepancies shall be reported to the Architect and the contractor shall obtain written instructions for

any changes necessary to accommodate the work under this contract with the work of others.

3.4 MAINTENANCE

A. Mount equipment so that maintenance personnel have clear access for calibration, repair, removal, and replacement services

3.5 INSTALLATION

A. The contractor shall install sensors in accordance with the manufacturer's recommendations.

B. The contractor shall mount sensors rigidly and adequately for the environment within which the sensor operates.

C. The contractor shall install all sensors in accessible locations.

D. Install labels and nameplates to identify control components according to Division 23 Section 230553 "Identification for HVAC Piping and Equipment."

E. Waterside Instruments:

1. Install instruments in accordance with manufacturer's requirements and applicable industry standards, including ISA-S 77.70.
2. Locate instruments to minimize effects of vibration, extreme ambient temperatures and moisture.
3. Locate instruments to allow for ease of access for normal operations and maintenance activities.
4. Install meters in accordance with AWWA M6, with isolating valves on inlet and outlet.
5. Install gauge taps in piping.
6. Install pressure gauges with pulsation dampers on lines subject to vibration.
7. Provide needle valve to isolate each gauge.
8. Install temperature sensors with thermowells in piping systems with threadolets and ensure minimum of 2 inch clearance from insulation.
9. Install temperature sensors a minimum of 3 pipe diameters away from major equipment (e.g., pumps or valves). Install thermowells in elbows for small pipe sizes.
10. Provide instruments with scale ranges selected according to service with largest appropriate scale.
11. Install gauges and thermometers in locations where they are easily read from normal operating level. Install vertical to 45 degrees off vertical.
12. Adjust gauges and thermometers to final angle, clean windows and lenses, and calibrate to zero.
13. Install flowmeters in accordance with manufacturer's upstream and downstream pipe straight run requirements.

F. Valves:

1. Install valves and valve operators to provide ease of access for operation, service, and removal without interference from structures, piping or other equipment.
2. Install valves in accordance with manufacturer's instructions and recommendations.
3. Install with stems upright or horizontal, not inverted.
4. Provide non-conducting dielectric connections when joining dissimilar metals.

G. Instrument Impulse Lines:

1. Instrument impulse lines include pipes, tubing, fittings and components used to connect the instrument to other piping or equipment starting at but not including the first block valve.
2. Slope impulse lines at a minimum of 1 inch per foot or greater slope.
3. Support impulse lines securely and firmly by bracketing from building steel, walls, instrument supports or stands. In no case shall the instrument serve to support the impulse line. Impulse lines, whether of tubing or pipe, must be fitted carefully and their configuration must be such that minimum stress of vibration is imposed upon the instrument.
4. Provide remote differential pressure and remote pressure transmitters with self-supporting type manifold valves. Installation is to be such that the transmitter can be removed without removing the manifold valve from the support or disconnecting any tubing.
5. Use thread compounds as follows unless otherwise specified:

    a. Pipe threads: Minus 50 degrees F to 500 degrees F – Use Teflon base paste such as Liquid "O" ring or equal.
    b. Bolt threads: Minus 50 degrees F to 500 degrees F – Use Graphite and Oil Compound.

6. The use of tubing for instrument impulse lines is preferred. Pipe may be substituted at the discretion of the field where tubing cannot be used because of problems of support, size, pressure ratings, materials of construction, etc. Any pipe or pipe fittings used must conform in all respects to the code of the process or service piping to which the impulse line connects.
7. Instrument impulse lines shall meet the requirements of specification Section 232113, Hydronic Piping.

H. Instrument Location and Support

1. Locate instruments to provide safe monitoring and maintenance access; and to maintain clearances required for walkways and access ways as well as for the operation and maintenance of valves and other equipment.
2. Locate primary instrument block valves, primary elements and instruments for access from grade, platform, stairway, permanent or portable ladder.

a. Access from portable ladders is limited to 15 feet above grade.
b. Above 15 feet, accessibility is to be from a platform having a 7 feet directly overhead limitation, or from a permanent ladder.

3. Mount individual instruments, except for blind type transmitters, with a centerline 4 feet, 6 inch above grade or on a platform on a vibration –free support. Process instrument piping is not to be used as support.
4. Mount non-indicating or blind transmitters on the line as close to the sensing point as possible. If accessibility, clearance, vibration or hydraulic shock, which may damage or affect the operation of the instrument is encountered, the instrument will be remote mounted.
5. Locate receiver type local indicators at each transmitter that is not part of a control loop.
6. If the transmitter is part of a control loop, locate the indicator at the control valve, visible from the bypass valve.
7. Mount instruments in vapor or gas service normally above the sensing point. Mount instruments in liquid or steam service (with condensate pots) normally below the sensing point. If accessibility, visibility or clearance requirements preclude either situation, provisions will be made in the instrument piping arrangement to insure proper operation of the instrument.
8. Steam service impulse lines shall be long enough to cool service below transmitter temperature rating. Provide a minimum of 2 feet for every 100 degrees F reduction required.
9. Mount remote mounted instruments at grade or platform using rigid pipe stand type supports. Where possible, remote mounted instruments should be grouped and utilize common supports.
10. Mount instruments on the line using rigid pipe supports, either the pipe clamp method or the saddle type. No welding of supports to process piping is permitted.
11. Locate differential pressure instruments in level services in the same horizontal plane with the lower connection.

3.6 FIELD QUALITY CONTROL

A. Inspections:

1. Verify installations against the piping and instrument diagram and installation details.
2. Visually inspect installation for damage. If damage is observed, it shall be recorded and corrective action taken.
3. Verify removal of temporary protective devices, restraints or stops.
4. Verify instruments and control valves/actuators are accessible from and not located in the operator aisle ways.
5. Verify that high and low side impulse piping of DP type instruments are connected to proper instrument ports with valve manifold.
6. Verify piping system for proper alignment, cleanliness and freedom from foreign materials prior to equipment installation.

7. Inspect threads on both the valve and mating pipe for correct thread form and cleanliness.
8. Inspect internal length of threads in the valve ends and proximity of the valve internal seat to ensure pipe will not hit the seat when assembled.
9. Inspect mating flange facings for conditions that might cause leakage.
10. Check flange bolting for proper size, length and material.
11. Check gasket materials for defects or damage.

B. Testing of instrument impulse piping shall be with nitrogen or other inert type of gas. Primary process pressure lines shall be tested to 150% of external differential design pressure of the primary process line to which it is connected, but no less than 15 psig.

C. Provide schedule at least 2 weeks in advance of testing activity and document test results; Owner reserves the right to witness testing activity.

D. Instrument Calibrations:

1. Provide factory calibrations of instruments to verify accuracy and linearity in accordance with standard industry practices or manufacturer's recommendations, whichever is more stringent.
2. Calibrations to check sensing element directly, electronics checking only is not acceptable.
3. Factory calibrations shall follow standard procedures. In lieu of factory calibrations the calibration data points shall be recorded in each direction (ramp up and ramp down): 0, 25, 50, 75, and 100 percent of range relative to a reference instrument. The reference instrument accuracy shall be ten times the accuracy required for the field instrument. Record data using NIST traceable instrumentation in applicable engineering units.
4. Provide labor, supervision, services, tools, special equipment and consumable supplies required to perform instrumentation and controls checkout and calibration.
5. Test equipment shall have a minimum accuracy four times equipment being calibrated, traceable to NIST.
6. Calibrate instruments individually or as a system where applicable.
7. Factory calibration and installation records shall be prepared and maintained with the following information:

    a. Tag number.
    b. Date component received.
    c. Purchase order number.
    d. Serial number.
    e. Calibration data.
    f. Date of calibration.
    g. Person performing calibration.
    h. Date component installed.
    i. Test Equipment: Manufacturer, model number, date calibrated, calibration lab, and accuracy.

j. Attach calibration sticker to the instrument. Submit sample calibration stickers to Owner for approval. Coordinate sticker location on each type of instrument with Owner. Sticker content:

1) Date calibrated.
2) Calibration due date.
3) Initials of person performing calibration.

8. Field verify instrument calibrations at 3 points (0, 50, and 100 percent) prior to start-up testing. Document verification with same information required for calibration records. If instrument is out-of-tolerance then recalibrate, recording 3 points in each direction.

E. Loop checks:

1. Field verify instrument loops from instrument terminal connection to the DCS HMI display at 3 points (0%, 50%, 100%) for analog points and each state (open/close, on/off) for discrete (digital) points.
2. Document results, including:

a. Dates started & completed.
b. Person(s) performing checks.
c. Verify 0%, 50%, and 100% points.
d. Discrete state changes (record actual value).
e. Problem description.
f. Corrective action description.

3.7 TRAINING

A. Provide training at the Owner’s facility for up to 10 persons for instrumentation and control equipment, including the following topics:

1. Theory of operation.
2. Hardware configuration and software programming.
3. Calibration methods.
4. Preventative and scheduled maintenance.
5. Diagnosis of hardware and software failures.
6. Removal and replacement of serviceable components.
7. Review content of manufacturer's installation, operation and maintenance manual.

END OF SECTION 230900

HYDRONIC PIPING
23 21 13

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes pipe and fitting materials and joining methods for the following:

1. Copper tube and fittings.
2. Steel pipe and fittings.
3. Joining materials.
4. Transition fittings.
5. Dielectric fittings.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of the following:

1. Pipe.
2. Fittings.
3. Joining materials.
4. Gaskets:

    a. Include manufacturer’s recommended torque for specified general service and high strength bolts, for all pipe sizes based on maximum systems pressure/temperature encountered, but not less than 150 PSIG at maximum service temperature of 150 deg F and 1/8-inch-thick gasket

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Piping layout, drawn to 1/4” scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Structural members.
2. Plumbing piping.
3. Chilled water piping
4. Condenser water piping
5. Ductwork
6. Fire protection piping
7. Heavy electrical conduit and cable trays
8. Equipment
9. Pipe anchors, hangers, supports, alignment guides, expansion joints and loops, and attachments of the same to the building structure.

B. Shop Drawings: Show enlarged details, sections, or isometrics as necessary of detailed piping layouts, 1/2 inch equals 1 foot scale or larger, of chemical feed and corrosion coupon rack assemblies, equipment connections, flow meter and control valve installations, pump assemblies, coils, branch piping reinforcements, and fabricated pipe anchors, fabricated hangers, and fabricated alignment guides, and their attachment to the building structure.

C. Qualification Data: For Installer.

1. Welding Procedures.
2. Welding Procedure Qualification Records (PQR's).
3. Welder Qualification Records.
4. Weld Records.
5. Independent Testing Agency Qualifications.
6. Welders' Certificates.

D. Field test reports.

1.5 QUALITY ASSURANCE

A. Steel Support Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Pipe Welding: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code: Section IX.

1. The fabrication and erection of all piping shall conform to the latest edition with all current revisions of ASME B31.9 and Section I of ASME Boiler and Pressure Vessel Code as defined in their scopes. In addition, the fabrication and erection of all piping shall conform to all applicable Federal, State, and Local laws.
2. Welding shall be in accordance with ASME Section IX. Methods and procedures shall be developed for all metals included in the Work and shall fully describe the number of beads, volts, amperes, and welding rods for various pipe thicknesses and materials. Procedures shall specify end preparation for butt welds including

cleaning, alignment, and root openings. Welding procedures shall be identified individually and shall be clearly referenced to the type of welding required for this project. These procedures shall be the same as those used for all pipe welder qualification tests, all shop welds, and all field welds. All welding procedures shall be submitted to Owner for approval prior to performing any welding.

3. Welder Qualification Testing:

   a. The Contractor shall hire an independent testing agency to qualify all welders, welding operators, and tackers assigned to work in accordance with ASME Section IX, Article III - Welding Performance Qualifications QW-300. Qualification of all welders is required regardless if welding is performed in the shop or the field. Qualification is also required for welders performing prefabrication welding of a piping system who may not be an employee of the Contractor.
   b. All welding for the qualifications testing shall be performed at the Contractor's shop or at the project site and witnessed by the independent testing agency. Notification shall be given to the owner or owner's representative 48 hours in advance of any qualifications testing.
   c. Persons administering the tests shall be employees of the independent testing agency and shall be certified according to AWS QC1. The qualifications of the persons administering the test shall be submitted for review 48 hours in advance of any qualifications testing.
   d. Each person tested shall be tested for the approved welding procedures that each person will perform. A person may only perform work for which he has been qualified by the independent testing agency at the job site. Individuals shall not perform welding unless they have been qualified.
   e. The Contractor shall bear all costs associated with testing and the independent testing agency.
   f. Qualification of welders is required (based on metallurgy being welded) regardless of the previous qualifications, certifications, or experience the person has.
   g. After achieving qualification, but before being assigned to work, all qualification records shall be submitted. Information shall include name of the person, type of welding, date qualified, and the firm and individual certifying the qualification tests.
   h. Renewal of qualification shall be required under the following conditions:
      1) When a person has not performed any welding process for a period of 3 months.
      2) When a person has not performed the specific welding process for a period of 3 months; the period may be extended to 6 months if they have performed other welding processes during the 3-month time.
      3) At the discretion of the Engineer, if there is a specific reason to question the ability of a person to perform a process, i.e., the identification of a failed weld discovered by visual, ultrasonic, or hydrostatic evaluation or testing.

4. Identification of welders:

   a. After achieving qualification, but before being assigned work, each qualified person shall be assigned an identifying number by the Contractor that shall then be used to identify all of his or her welds. A list of qualified persons with their respective numbers shall be submitted by the Contractor and shall be maintained accurately with deletions and additions reported promptly.
   b. Upon completing a joint, the welder shall mark the pipe not more than 6 inches from the weld with the identifying number and the last two digits of the year in which the work was performed. Identification marks shall be made by using a rubber stamp or felt-tipped marker with permanent, weatherproof ink or other methods approved by the Engineer that do not deform the metal. For seam welds, identification marks shall be placed adjacent to the welds at 3-foot intervals. Identification by die stamps or electric etchers will not be allowed. For schedule 10S and under stainless steel, the stamping shall be on a stainless steel tag of the same pipe material welded to the pipe not more than 6 inches from the weld. These markers, bands, and stainless steel tags are to be provided by the Contractor. Substituting a map of welds with welders' names shall not be acceptable.

5. Weld records:

   a. For all welding within the scope of ANSI/ASME B31.9, the Contractor shall submit to the Engineer for approval an administrative procedure for recording, locating, monitoring and maintaining the quality of all welds to be performed on the project.
   b. This quality control document record shall include but not be limited to:

      1) Drawings and schedules identifying location of each weld by individual number.
      2) Identification of welder who performed each weld by individual welder's name, stamp number, date, and Welding Procedures Specification (WPS) used.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Hydronic piping components and installation shall be capable of withstanding the following minimum working pressure and temperature unless otherwise indicated:

   1. Chilled-Water Piping: 150 psig at 110 deg F.

2. Blowdown-Drain and Air-Vent Piping: Equal to the pressure of the piping system to which it is attached.
3. Safety-Valve-Inlet and -Outlet Piping: Equal to the pressure of the piping system to which it is attached.

2.2 COPPER TUBE AND FITTINGS

A. Drawn-Temper Copper Tubing: ASTM B88, Type L.

B. DWV Copper Tubing: ASTM B306, Type DWV.

C. Wrought-Copper Unions: ASME B16.22.

2.3 STEEL PIPE AND FITTINGS

A. Steel Pipe: ASTM A53, black steel, plain ends for threading and beveled ends for welding, Type, Grade, and Schedule as indicated in Part 3 piping applications articles.

B. Cast-Iron Threaded Fittings: ASME B16.4; Classes 125 and 250 as indicated in "Piping Applications" Article.

C. Malleable-Iron Threaded Fittings: ASME B16.3, Classes 150 and 300 as indicated in "Piping Applications" Article.

D. Malleable-Iron Unions: ASME B16.39; Classes 150, 250, and 300 as indicated in "Piping Applications" Article.

E. Cast-Iron Pipe Flanges and Flanged Fittings: ASME B16.1, Classes 25, 125, and 250; raised ground face, and bolt holes spot faced as indicated in "Piping Applications" Article.

F. Wrought-Steel Fittings: ASTM A234/A234M, wall thickness to match adjoining pipe.

G. Wrought Cast- and Forged-Steel Flanges and Flanged Fittings: ASME B16.5, including bolts, nuts, and gaskets of the following material group, end connections, and facings:

1. Material Group: 1.1.
2. Flange Type: Welded Neck
3. End Connections: Butt welding.
4. Facings: Raised face or ground smooth for connection to Class 125 fittings when necessary

H. Steel Pipe Nipples: ASTM A733, made of same materials and wall thicknesses as pipe in which they are installed.

2.4 JOINING MATERIALS

A. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents. The supplier of each gasket is to review the chemical compositions of the fluids being transferred, the temperatures and pressures of the fluids, and the type of flange that is used and shall select the gaskets based on those conditions. He shall provide a recommendation in writing for the types of gaskets selected and shall submit these with the submittals.

B. Flat-Face Gasket Material:

1. General for Flat-Face Gasket Materials: ASME/ANSI B16.21, nonmetallic, flat, asbestos free, 1/8-inch maximum thickness unless thickness or specific material is indicated. Use for flat-face, Class 125, cast-iron and cast-bronze flanges and for steel flanges where the raised-face has been removed.
2. Type CS: Compressed non-asbestos composition sheet blend of synthetic fibers with SBR binder, non-stick coating, 1/8 inch thick.

    a. Applications: Water, Saturated Steam, inert gases

        1) Garlock, Blue Guard Style 3200 (Derated to 400 deg F)
        2) Chesterton Style 192 (Derated to 700 deg F)
        3) Sepco Style 200
        4) Lamons Gasket Co.

3. Type RR: Red Rubber / SBR (Styrene Butadiene) 65 to 70 Shore A Durometer, 180 deg F / 150 PSIG maximum, 600 psig tensile strength

    a. Applications: Hot or cold water, air, and steam.
    b. Full face, for up to 6-inch diameter pipe, 1/16 inch thick
    c. For 6 inch and larger pipe, 1/8 inch thick.

        1) John Crane Style 555S for pressures not exceeding 90 PSI
        2) Garlock Style 22
        3) Sepco Style 20
        4) Chesterton Style 100
        5) Lamons Gasket Co.

C. Raised-Face Gasket Material

1. General for Raised-Faced Gasket Materials: ASME/ANSI B16.20, metallic, flat, asbestos free, 304 Stainless Steel Spiral Wound Graphite, and spiral-wound metal gaskets. Use for raised-face, Class 250, cast-iron and raised-face steel flanges.
2. Type – SPW: Low seating stress, spiral wound; dead-soft type 304 stainless steel, unless otherwise specified or recommended by manufacturer for specific

product/service; 0.175-inch-thick, with 0.125-inch-thick external centering and internal rings.

a. Flexitallic Style LSI (Low Stress) for Class150, Class 250, and Class 300 flanges
b. Lamons Gasket Co.
c. Metallo Gasket Co. Style 515

D. Flange Bolts and Nuts: ASME B18.2.1, carbon steel piping, unless otherwise indicated. Bolts and studs, high strength, ASTM A-193 Gr B8 with 2 extra heavy hex nuts A-194 B8.

E. Solder Filler Metals: ASTM B32, lead-free alloys. Include water-flushable flux according to ASTM B813.

F. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for joining copper with copper; or BAg-1, silver alloy for joining copper with bronze or steel.

G. Welding Filler Metals: Comply with AWS D10.12M/D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

2.5 DIELECTRIC FITTINGS

A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.

B. Dielectric Unions:

1. Description:

a. Standard: ASSE 1079.
b. Pressure Rating: 150 psig.
c. End Connections: Solder-joint copper alloy and threaded ferrous.

C. Dielectric Flanges:

1. Description:

a. Standard: ASSE 1079.
b. Factory-fabricated, bolted, companion-flange assembly.
c. Pressure Rating: 150 psig.
d. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

D. Dielectric-Flange Insulating Kits:

1. Description:

    a. Nonconducting materials for field assembly of companion flanges.
    b. Pressure Rating: 150 psig.
    c. Gasket: Neoprene or phenolic.
    d. Bolt Sleeves: Phenolic or polyethylene.
    e. Washers: Phenolic with steel backing washers.

E. Dielectric Nipples:

1. Description:

    a. Standard: IAPMO PS 66.
    b. Electroplated steel nipple, complying with ASTM F1545.
    c. Pressure Rating: 300 psig at 225 deg F.
    d. End Connections: Male threaded or grooved.
    e. Lining: Inert and noncorrosive, propylene.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

A. Chilled-water piping, aboveground, interior, shall be the following:

1. NPS 2 and smaller: ASTM B-88 Type L, hard drawn-temper copper tubing, wrought or cast bronze pressure fittings conforming to ASTM B 61, B 62, or B 75 and 95-5 soldered joints. Use flanges and dielectric couplings where necessary to connect dissimilar metals or flanged components.
2. NPS 2-1/2 and larger: ASTM A53, Schedule 40, Type E or S, Grade B, steel pipe; ASTM A 234 WPB wrought-steel butt-weld fittings, flanges, and flange fittings; and welded and flanged joints.
3. Piping shall be painted per the requirements of specification Section 230000: Mechanical General Provisions.

B. Blowdown-Drain Piping: Same materials and joining methods as for piping specified for the service in which blowdown drain is installed.

C. Air-Vent Piping:

1. Inlet: Same as service where installed with metal-to-plastic transition fittings for plastic piping systems according to piping manufacturer's written instructions.
2. Outlet: Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered joints.

3.2 PIPING INSTALLATIONS

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

E. Install piping to permit valve servicing.

F. Install piping at indicated slopes.

G. Install piping free of sags and bends.

H. Install fittings for changes in direction and branch connections.

I. Install piping to allow application of insulation.

J. Select system components with pressure rating equal to or greater than system operating pressure.

K. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.

L. Install drains, consisting of a tee fitting, NPS 3/4 ball valve, and short NPS 3/4 threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.

M. Provide vents at high points and drains at low points in mains, risers, and branch lines consisting of a tee, reducing tee, weld-o-let, or soc-o-let fitting, applicable 3/4 inch shut-off valve, 3/4 inch nipple, and cap for pipe sizes 6 inches and smaller; provide 2 inch shut off valve, nipple, and cap for pipe sizes 8 inches and larger. All components shall conform to the piping systems described in this Section. The location of the high point vents and low point drains shall be approved by the Engineer.

N. Install piping at a uniform grade of 0.2 percent upward in direction of flow.

O. Reduce pipe sizes using eccentric reducer fitting installed with level side up.

P. Install branch connections to mains using tee fittings in main pipe, with the branch connected to the bottom of the main pipe. For up-feed risers, connect the branch to the top of the main pipe.

Q. Install valves according to the following:

1. Section 230523 "General Duty Valves for HVAC Piping."

R. Install unions in piping, NPS 2 and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.

S. Install flanges in piping, NPS 2-1/2 and larger, at final connections of equipment and elsewhere as indicated.

T. Install shutoff valve immediately upstream of each dielectric fitting.

U. Comply with requirements in Section 230553 "Identification for HVAC Piping and Equipment" for identifying piping.

V. Install sleeves for piping penetrations of walls, ceilings, and floors.

W. Install sleeve seals for piping penetrations of concrete walls and slabs.

3.3 DIELECTRIC FITTING INSTALLATION

A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.

B. Dielectric Fittings for NPS 2 and Smaller: Use dielectric unions.

C. Dielectric Fittings for NPS 2-1/2 to NPS 4: Use dielectric flanges.

D. Dielectric Fittings for NPS 5 and Larger: Use dielectric flange kits.

3.4 HANGERS AND SUPPORTS

A. Comply with requirements in Section 230529 "Hangers and Supports for HVAC Piping and Equipment" for hanger, support, and anchor devices. Comply with the following requirements for maximum spacing of supports.

B. Install the following pipe attachments:

1. Adjustable steel clevis hangers for individual horizontal piping less than 20 feet long.
2. Adjustable roller hangers and spring hangers for individual horizontal piping 20 feet or longer.

3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feet or longer, supported on a trapeze.
4. Spring hangers to support vertical runs.
5. Provide copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.

C. Install hangers for steel piping with the following maximum spacing and minimum rod sizes:

1. NPS 3/4: Maximum span, 7 feet.
2. NPS 1: Maximum span, 7 feet.
3. NPS 1-1/2: Maximum span, 9 feet.
4. NPS 2: Maximum span, 10 feet.
5. NPS 2-1/2: Maximum span, 11 feet.
6. NPS 3 and Larger: Maximum span, 12 feet.

D. Install hangers for drawn-temper copper piping with the following maximum spacing and minimum rod sizes:

1. NPS 3/4: Maximum span, 5 feet; minimum rod size, 1/4 inch.
2. NPS 1: Maximum span, 6 feet; minimum rod size, 1/4 inch.
3. NPS 1-1/4: Maximum span, 7 feet; minimum rod size, 3/8 inch.
4. NPS 1-1/2: Maximum span, 8 feet; minimum rod size, 3/8 inch.
5. NPS 2: Maximum span, 8 feet; minimum rod size, 3/8 inch.
6. NPS 2-1/2: Maximum span, 9 feet; minimum rod size, 3/8 inch.
7. NPS 3 and Larger: Maximum span, 10 feet; minimum rod size, 3/8 inch.

E. Support vertical runs at roof, at each floor, and at 10-foot intervals between floors.

3.5 PIPE JOINT CONSTRUCTION

A. To the extents possible, the Contractor shall construct joints in their shop, prior to shipment to site for erection. The Contractor shall minimize the quantity of field welds required.

B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

D. Copper pipe and tubes: Thoroughly clean tube surface and inside surface of the cup of the fittings, using very fine emery cloth, prior to making soldered or brazed joints. Wipe tube and fittings clean and apply flux. Flux shall not be used as the sole means for cleaning tube and fitting surfaces.

E. Soldered Joints: Apply ASTM B813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B32.
   1. Use 15% silver/copper solder for soldered joints.

F. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8/A5.8M.

G. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

   1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
   2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

H. Welded Joints: Construct joints according to AWS D10.12M/D10.12, using qualified processes and welding operators according to "Quality Assurance" Article.

   1. All welding on metal piping systems shall be done using qualified welding procedures and qualified welders and welding operators in accordance with Section IX of the ASME Boiler and Pressure Vessel Code. All welding shall be done according to a process that is compatible with the work being welded and the working conditions. Shielded metal-arc welding (SMAW) shall not be used on work less than 3/16 inch thick.
   2. Welding shall be completed using only the following processes:

      a. Shielded Metal Arc Welding (SMAW), also known as "stick" welding.
      b. Gas Tungsten Arc Welding (GTAW), also known as TIG and Heliarc welding.
      c. Submerged Arc Welding (SAW).

   3. Fabrication, installation, inspection, examination and testing shall be in accordance with ANSI/ASME B31.9 as applicable.
   4. Backing rings (chill rings) or consumable inserts are not allowed.
   5. All completed welds shall be wire brushed a minimum of 2 inches on either side and coated with a coat of high temperature (500ºF) primer prior to being insulated.
   6. To the extent practical, weld pipe joints only when ambient temperature is above 50 degree F.
   7. Bevel pipe ends per approved WPS, smooth rough cuts, and clean to remove slag, metal particles, and dirt.
   8. Use pipe clamps or tack-weld joints with 1-inch long welds; 4 welds for pipe sizes to 10 inches, 8 welds for pipe sizes 12 inches to 20 inches.

9. Build up welds with stringer-bead pass, followed by hot pass, followed by cover or filler pass. Eliminate valleys at center and edges of each weld. Weld by procedures that will ensure elimination of unsound or un-fused metal, cracks, oxidation, blowholes, and non-metallic inclusions.
10. Do not weld-out piping system imperfections by tack-welding procedures; re-fabricate to comply with requirements.
11. Wherever branch pipe is indicated, install type of fitting shown on Drawings, i.e. forged branch connection fitting, regular "T" fitting, or reducing "T" fitting. If the type of fitting is not shown on the Contract Drawings, the Installer may choose between the above mentioned fittings, within the limits of the following:

    a. Forged branch connection fittings may only be used if the smaller branch pipe is at least two standard nominal pipe sizes smaller than the larger main pipe.
    b. All fittings and procedures conform to the specific piping group specification as scheduled in this Section.
    c. The Contractor shall provide taps into existing mains that will remain energized at up to piping system design pressure where a hot tap is specifically indicated on the Contract Drawings. This procedure is also known as wet tapping. Experienced personnel with special hot tap fabrication equipment shall perform all hot or wet tapping. All hot tapping shall be coordinated with the Owner. Hot tapping is only allowed where indicated on the Contract Drawings or by written approval from the Engineer and the Owner. Where utilized, hot tap procedures shall be submitted to Engineer for approval prior to proceeding.

12. If piping component ends are bored, such boring shall not result in the finished wall thickness after welding less than the minimum design thickness (nominal thickness minus 12.5% manufacturer's tolerance). The inside diameters of piping components to be butt-welded shall be aligned as accurately as is practicable within existing commercial tolerances on diameters, wall thickness and out of roundness. Alignment shall be preserved during welding. The internal misalignment of the ends to be joined shall not exceed 0.05 inch, without the use of lateral restraints.
13. Welding Groves:

    a. The ends of steel pipe and fittings to be erected with butt welded joints shall be beveled to form welding grooves in accordance with ANSI B16.25, except where otherwise noted in these Specifications, or on the Contract Drawings.
    b. Welding grooves for butt-welded joints in pipe of unequal wall thickness shall be beveled in accordance with ASME Code for Pressure Piping B31.9 - latest edition, latest revision and section that is applicable.

14. Weld Cleaning: All slag or flux remaining on the bead of welding shall be completely removed before laying down the next successive bead and at the completion of the weld.
15. Preheating of Welded Joints: Pipe adjacent to joints before and during welding shall be preheated by any suitable method in accordance with the qualified welding procedure and in all cases shall be in accordance with ASME B31.9.
16. Weld Quality:

    a. All welds shall have full penetration and complete fusion with a minimum of weld metal protruding on the inside of the pipe.
    b. The finished weld contour shall be uniform, with the toe or edge of the weld merging smoothly into the base material. Butt welds shall have a slight reinforcement build-up gradually from the toe or edge toward the center of the weld. The limitation on butt weld reinforcement shall be in accordance with ASME B31.9, Section 936.6.1 and shall apply separately to both inside and outside surfaces of the joint. Fillet welds may be slightly concave on the furnished surface.

I. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

1. Match flanges within piping system and at connections with valves and equipment where specified. Clean flange faces and install gaskets. Tighten bolts to provide uniform compression of gaskets.
2. After bolts are tightened to their required torque value, mark a line in permanent ink on bolt and nut.
3. Slip-on flanges shall only be used where specifically shown or otherwise approved by Engineer. All slip-on flanges are to be welded on front and back.
4. Welding neck flanges shall be bored to match the attached pipe.

3.6 VISUAL EXAMINATION

A. General: Visually examine pipe welds as described below. The Contractor shall perform visual examination of welds. However, the Owner reserves the right to inspect all piping/fabrication at any time.

B. Acceptance Standards
1. The acceptance standards for visual examination shall be as defined in ASME B31.1, Paragraph 136.4.2.A
2. In addition, acceptance will also be based on the proper layout, materials, and methods, as specified.

C. Failed Welds

1. Welds not passing visual examination shall be repaired or replaced at no expense to the Owner.
2. Do not begin to repair or replace the weld until the weld report has been submitted to the Owner's Representative and the Owner's Representative gives approval for repairing the weld with the method that the Contractor proposes.
3. All failed welds shall be re-examined using the same examination methodology after the weld is repaired or replaced at no additional cost to the Owner.

D. Documentation

1. When the independent testing agency is specified to perform the visual examinations, the report of each weld examination shall be submitted to the Engineer within three working days of the examination. Reports performed for visual examinations by the Contractor are not required to be submitted, but shall be kept available for review at any time by the Engineer.
2. Weld reports shall include the following:

    a. Date of weld examination.
    b. Type of examination.
    c. Examiner's name.
    d. Welders' names including all persons who worked on the weld and their work involved.
    e. Piping system.
    f. Weld location.
    g. Weld procedure and materials.
    h. Materials and dimensions of items that were welded.
    i. Visual examination results.

E. Examiners' Qualifications:

1. Persons performing visual examinations and evaluating examinations shall be certified according to AWS QC1 whether an employee of the independent testing agency or the Contractor.
2. Credentials and certification of all examiners must be submitted and approved prior to an examiner performing the initial examination.

F. Visual Examination Requirements

1. Welds designated for visual examination shall be examined as follows:

    a. Before welding - for compliance with requirements for joint preparation, alignment and fit-up, cleanliness, condition of welding equipment, quality and condition of base and filler materials to be used, and preheat, when required.
    b. During welding - for cracks, conformance to the qualified welding procedure, quality of individual weld passes, interpass temperature,

placement and sequencing of individual weld passes, and back gouged surfaces.

c. After welding - for cracks, contour and finish, bead reinforcement, undercutting, overlap, size of fillet welds, finished weld appearance, weld size, weld length, dimensional accuracy of weldment, and monitor post weld heat treatment.

2. Records of visual examinations must be kept as described in this Section.
3. Visually examine a weld examined by ultrasonic or radiographic examination.
4. Shop fabricated welds may be examined in the shop prior to arrival at the project site provided all other conditions of this Section are satisfied.

3.7 PRESSURE TESTING

A. Except as otherwise specified herein, all piping shall be hydrostatically tested in accordance with Paragraph 937 of the ASME B31.9 Pressure Piping Code.

B. Owner and Engineer shall be provided notification, in writing, a minimum of two (2) weeks prior to testing.

C. Provide written test procedures for Hydrostatic testing for the Owner and Engineer's review. Review and approval shall be obtained prior to the start of any testing. The written procedure shall, at a minimum, contain the following items:

1. Fully describe the test circuit or system to be tested. Provide a colored piping drawing outlining the piping that will be tested in each circuit.
2. Identify all valve locations and positions (opened or closed) for test purposes.
3. Examine systems and identify any in-line devices or equipment that must be isolated or removed from the circuit during the test due to over-pressurization concerns.
4. Describe the pressure test injection manifold location, configuration, and components. Identify test pressure monitoring location if different from the injection manifold location. Generally, monitoring location should be within 5 feet elevation of system low point.
5. Identify testing instruments by manufacturer, model, serial number, graduated range, and certification date.
6. Identify the test medium to be used; including the actual source.
7. Identify required safety precautions that will be utilized for personnel and equipment protection.
8. Describe the pre-test filling procedures including the identification of all venting locations and methods.
9. Define the methods of joint inspection that will be used.
10. Describe the procedure for post-test system depressurization and draining including locations.

11. Describe post test system blow-down (purging) with compressed air to remove moisture in specified systems.

D. General:

1. Provide temporary equipment for testing, including pump and gages. Test gage(s) shall be installed at the highest elevation in the system to be tested. The gage shall be accurate to within 3 psig and shall be calibrated within six months of the test as recorded on a sticker on the gage.
2. Test piping system before insulation is installed.
3. Pressure testing shall be performed following the completion of post weld heat treatment, nondestructive examinations, and all other fabrication, assembly, and erection activities required to provide the system subjected to the pressure test with pressure retaining capability.
4. Remove control devices before testing.
5. Test each natural section of each piping system independently but do not use piping system valves to isolate sections where test pressure exceeds valve pressure rating.
6. Fill each section with water and pressurize for indicated pressure and time.
7. Use taps installed at the high points of system to release trapped air while filling system. Use drip legs installed at system low points for complete removal of liquid. Install additional high point vents and low point drains as required to facilitate testing, drainage, and flushing.
8. Leave joints, including welds, un-insulated and exposed for inspection during system hydrostatic pressure test.
9. Isolate all equipment that shall not be subjected to test pressures. If a valve is to be used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve or equipment; otherwise properly sized blinds shall be installed to isolate equipment. Flanged joints where blinds are inserted to isolate equipment shall be service tested.
10. Provide temporary restraints for expansion. If temporary restraints are impractical, isolate expansion joints from testing.
11. Install a properly sized relief valve set at a pressure no more than 15 PSIG higher than test pressure, to protect against damage by expanding liquid or other source of overpressure during test. Safety valves shall be capable of relieving the overpressure at a higher rate than the injection manifold is capable of pressurizing the system.

E. Test Medium: All piping subjected to hydrostatic pressure testing shall utilize approved water supplies furnished by the Owner. Unless otherwise specified or required by manufacturer's recommendations, hydrotesting shall be accomplished using city water.

F. Test Pressure:

1. The hydrostatic test pressure shall be as defined in Paragraph 937.3.4 of the ASME B31.9 Pressure Piping Code. At a minimum, the test pressure shall be

1.5 times the design pressure for each pipeline as identified within this specification.

2. The test pressure shall be continuously maintained for a minimum time of 10 minutes and may then be reduced to design pressure and held for a minimum of 2 hours or as may be necessary to conduct the examinations for leakage. Examinations for leakage shall be made of all joints and connections. The piping system shall show no visual evidence of weeping or leaking.
3. Contractor shall repair any leaks and re-test at his own expense.
4. Where sections of existing piping are being replaced or rerouted, the new section(s) of pipe shall be hydrostatically tested prior to final connection to the existing system. Final tie-in connections shall then be subjected to Initial Service Testing in accordance with section 937.5 of ASME B31.9.

G. Test Blinds:

1. If during the field testing of piping it becomes necessary to insert test blinds in any part of this piping, the Contractor shall provide test blinds.
2. Test blinds shall be equipped with a long handle.
3. The Contractor shall submit a written description of the location of test blinds before testing.
4. The Contractor shall remove all test blinds after testing.

H. Repair piping systems sections which fail required piping test, by disassembly and re-installation, using new materials to extent required to overcome leakage. Do not use chemicals, stop-leak compounds, mastics, or other temporary repair methods.

I. Documentation:

1. Keep accurate, updated records of all hydrostatic testing. The Contractor shall submit a final log of all hydrostatic testing for the Owner's records.
2. Maintain a constantly updated listed of the following for all hydrostatic tests:

    a. Date and time of test.
    b. Hydrostatic test pressure.
    c. Piping system tested.
    d. Extent of piping system tested so that it can be clearly identified up to what point a piping system has been tested.
    e. Test results. All failures shall be indicated with the cause explicitly stated. Signed witnesses of each test which shall be one employee of the Contractor, by the Owner, and by the Engineer.

3.8 CLEANING, FLUSHING, AND PASSIVATION OF CARBON STEEL

A. Refer to Section 232550 "Flushing, Cleaning, and Passivating Chilled Water Systems”.

3.9 INSULATION, PAINTING, AND IDENTIFICATION

A. Refer to Section 230719 – MECHANICAL INSULATION for process pipe insulation requirements.

B. Piping identification shall be in accordance with Section 23 05 53 – IDENTIFICATION FOR PIPING AND MECHANICAL EQUIPMENT.

C. Paint piping as specified in Section 23 00 00 – MECHANICAL GENERAL PROVISIONS.

END OF SECTION 232113

UNDERGROUND HYDRONIC PIPING
23 21 13.13

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Pre-insulated Chilled Water Pipe and Fittings (refer to Section 232113 for operating pressures/temperatures of chilled water system)

B. Butterfly Valves

1.2 REFERENCE STANDARDS AND CODES

A. The equipment, materials and services furnished under this specification shall meet or exceed the requirements of all applicable federal, state and local codes, as well as the following specific standards and regulations:

1. ASME B16.1 – Grey Iron Pipe Flanges.
2. ASME B16.9 – Factory-Made Wrought Steel Butt-welding Fittings.
3. ASME B16.25 – Butt-welding Ends.
4. ASME B31.9 – Building Services Piping.
5. ASME B36.10M – Welded and Seamless Wrought Steel Pipe.
6. ASME Boiler & Pressure Vessel Code Section IX – Welding and Brazing Qualifications.
7. ASTM A53 - Standard Specification for Pipe, Steel, Black and Hot Dipped, Zinc Coated, Welded and Seamless.
8. ASTM A105 – Standard Specification for Carbon Steel Forgings for Piping Applications.
9. ASTM A106 - Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service
10. ASTM A234/A234M - Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service.
11. ASTM A536 – Standard Specification for Ductile Iron Castings.
12. ASTM A564 – Standard Specification for Hot Rolled and Cold Finished Age Hardening Stainless Steel Bars and Shapes.
13. ASTM C518- Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.
14. AWS QC1 – Standard for AWS Certification of Welding Inspectors.
15. AWWA C504 – Rubber Seated Butterfly Valves, 3 In. through 72 In.

B. While a number of applicable sections of the aforementioned codes and standards have been identified in portions of this specification, the contractor has the ultimate

responsibility for the complete identification and execution of all applicable sections of the aforementioned codes and standards.

C. Unless otherwise stated, these codes, standards or material specifications shall be the latest revisions, including all effective publications, supplements, addenda and editions in effect at the issuance date of this document.

D. These codes and standards set forth the minimum requirements. These may be exceeded by the contractor if, in its judgment and with the Owner's acceptance, superior or more economical designs or materials are available.

E. The most severe requirements shall prevail in the event of conflict between requirements, specifications and applicable and governing codes. All conflicts among the codes, specifications and/or purchase order shall be brought to the Owner's attention for written resolution prior to release for fabrication.

F. It is the contractor's responsibility that all equipment and materials furnished and installed be in strict conformity with all current, applicable codes and regulations of the state of Texas. Violations resulting from stipulations in the existing codes shall be corrected by the contractor at its own expense.

G. The contractor shall be responsible for obtaining copies and paying all costs of all applicable codes and regulations.

1.3 SUBMITTALS

A. Product Data: Submit data on pipe materials, fittings, valves, insulation, and jacket materials. Provide manufacturers catalog and additional supporting information as required to show compliance with specifications and standards. Include certified copies of mill tests reports and, in catalog data, mark specific model, type, sizes, etc. as applicable.

B. Shop Drawings: For underground hydronic piping. Signed and sealed by a professional engineer.

1. Calculate requirements for expansion compensation, anchors, guides, thrust blocks, etc. for underground piping.
2. Show expansion compensators, offsets, and loops with appropriate materials to allow piping movement in the required locations. Show anchors and guides that restrain piping movement with calculated loads, and show concrete thrust block dimensions.
3. Show pipe sizes, locations, and elevations. Show piping in trench, conduit, and cased pipe with details showing clearances between piping, and show insulation thickness.

C. Profile Drawings: Show system piping in elevation. Draw profiles at horizontal scale of not less than 1-inch equals 50 feet (1:500) and at vertical scale of not less than 1-inch equals 5 feet (1:50). Indicate manholes and piping. Show types, sizes, materials, and elevations of other utilities crossing hydronic piping.

D. Provide all compliance certificates, inspection reports, hydrostatic tests, material certificates, maintenance manuals, installation procedures/manuals, dimensions and spare parts list associated with valves.

E. Certify that products meet or exceed specified requirements.

F. Provide the following welding documents.

1. Welding Procedures.
2. Welding Procedure Qualification Records (PQR's).
3. Welder Qualification Records.
4. Weld Records.
5. Independent Testing Agency Qualifications.
6. Welders' Certificates.

G. Provide the following test documents.

1. Hydrostatic Testing Records. Log shall be available to the Engineer and Owner at all times. Final log shall be submitted to the Owner.
2. Visual Examination Examiners' Qualifications.
3. Visual Inspection Reports.
4. Independent Testing Agency Information. The contractor and independent testing agency shall provide a signed statement that the testing agency has no affiliation with the contractor and can serve as an independent agency to provide testing as specified.
5. Welder Identification List.

1.4 QUALITY ASSURANCE

A. The fabrication, installation and testing of all steel piping shall conform to the latest edition with all current revisions of ASME B31.9. In addition, the fabrication and erection of all piping shall conform to all applicable Federal, State, and Local laws.

B. Welding shall be in accordance with ASME Section IX. Methods and procedures shall be developed for all metals included in the work and shall fully describe the number of beads, volts, amperes, and welding rods for various pipe thicknesses and materials. Procedures shall specify end preparation for butt welds including cleaning, alignment, and root openings. Welding procedures shall be identified individually and shall be clearly referenced to the type of welding required for this project. These procedures shall be the same as those used for all pipe welder qualification tests, all shop welds and all

field welds. All welding procedures shall be submitted to the Owner for approval prior to performing any welding.

C. The contractor shall hire an independent testing agency to qualify all welders, welding operators, and tack welders assigned to work in accordance with ASME Section IX, Article III - Welding Performance Qualifications QW-300. Qualification of all welders is required regardless if welding is performed in the shop or the field. Qualification is also required for welders performing prefabrication welding of a piping system who may not be an employee of the contractor.

D. All welding for the qualifications testing shall be performed at the contractor's shop or at the project site and witnessed by the independent testing agency. Notification shall be given to the Owner 48 hours in advance of any qualifications testing.

1. Persons administering the tests shall be employees of the independent testing agency and shall be certified according to AWS QC1. The qualifications of the persons administering the test shall be submitted for review 48 hours in advance of any qualifications testing.
2. Each person tested shall be tested for the approved welding procedures that each person will perform. A person may only perform work for which he has been qualified by the independent testing agency. Individuals shall not perform welding unless they have been qualified.
3. The contractor shall bear all costs associated with testing and the independent testing agency.
4. Qualification of welders is required (based on metallurgy being welded) regardless of the previous qualifications, certifications, or experience the person has.
5. After achieving qualification, but before being assigned to work, all qualification records shall be submitted. Information shall include name of the person, type of welding, date qualified, and the firm and individual certifying the qualification tests.
6. Renewal of qualification shall be required under the following conditions.

    a. When a person has not performed any welding process for a period of 3 months.
    b. When a person has not performed the specific welding process for a period of 3 months; the period may be extended to 6 months if they have performed other welding processes during the 3-month time.
    c. At the discretion of the Owner, if there is a specific reason to question the ability of a person to perform a process, i.e., the identification of a failed weld discovered by visual, ultrasonic, or hydrostatic evaluation or testing.

E. After achieving qualification, but before being assigned work, each qualified person shall be assigned an identifying number by the contractor that shall then be used to identify all of his or her welds. A list of qualified persons with their respective numbers shall be submitted by the contractor and shall be maintained accurately with deletions and additions reported promptly.

F. For all welding within the scope of ANSI/ASME B31.9, the contractor shall submit an administrative procedure for recording, locating, monitoring and maintaining the quality of all welds to be performed on the project. This quality control document record shall include but not be limited to the following.

1. Drawings and schedules identifying location of each weld by individual number.
2. Identification of the welder who performed each weld by individual welder's name, stamp number, date, and Welding Procedures Specification (WPS) used.

G. Butterfly valves shall be tested at the factory after complete assembly for a full differential pressure of 150 psig with zero leakage across the seat.

PART 2 - PRODUCTS

2.1 PRE-INSULATED PIPE AND FITTINGS

Provide pre-insulated underground chilled water piping only where shown on the drawings.

A. Approved Manufacturers

1. Thermacor Process, Inc.
2. Perma-Pipe, Inc.
3. Insul-Pipe Systems, Inc.

B. Material Requirements

1. Furnish a complete HDPE jacketed system of factory pre-insulated steel piping for chilled water service. All pre-insulated pipe, fittings, insulating materials, and technical support shall be provided by the pre-insulated piping manufacturer.
2. The carrier pipe shall be ASTM A106, Grade B, seamless, schedule 40 for sizes up to 12”; standard weight for sizes above 12”. All pipe shall have 37 ½° beveled ends for butt welding.
3. Carrier fittings shall be ASTM A234, WPB seamless, with same pipe schedule as adjoining piping. All fittings shall have 37 1/2° beveled ends for butt welding. All elbows shall be long radius.
4. The insulation shall be polyurethane foam either spray applied or injected with one shot into the annular space between the carrier pipe and jacket. The insulation shall be rigid, 90% minimum closed cell polyurethane with a minimum 2.0 lbs. per cubic foot density, compressive strength of 30 psi, and coefficient of thermal conductivity (K-Factor) of not higher than 0.16 @ 75°F per ASTM C-518. The minimum insulation thickness shall be 2”.
5. The jacketing material shall be extruded, black, high density polyethylene (HDPE), having a wall thickness not less than 100 mils for jacket sizes less than or equal to 12”, 125 mils for jacket sizes larger greater than 12”. No tape jacket is allowed.

The inner surface of the HDPE jacket shall be oxidized by means of corona treatment, flame treatment, or other approved methods, to ensure a secure bond between the jacket and foam insulation preventing any ingression of water at the jacket/ foam interface.

6. Joints shall be field-insulated per the manufacturer's instructions, using polyurethane foam poured in an HDPE sleeve and sealed with heat shrink tape. All joint closures and insulation shall occur at straight sections of pipe. Insulation and jacket materials for pipe joints shall be supplied by the manufacturer.

2.2 BURIED PIPE REPAIRS

A. Short segments or areas of direct buried pipe which has been exposed due to removal of pre-insulation: Cover with STAC Coating System products including STACprime, STACfill, STACwrap and STACguard.

2.3 BURIED WARNING AND IDENTIFICATION TAPE

A. Provide detectable warning tape equal to that manufactured by Stanco, Inc. Tape shall have solid aluminum core laminated with protective clear film on both sides to protect graphics from underground moisture, acids and alkalis. Tape shall follow APWA uniform color code. Tape shall include continuously repeated graphics reading "Caution Buried Chilled Water Line" (blue).

2.4 BUTTERFLY VALVES,

1. Henry Pratt Company.
2. Owner approved equal.

B. Material Requirements

1. Butterfly valves shall be in accordance with AWWA C504, Class 150 rated working pressure.
2. The body shall be constructed of cast iron ASTM A-126 Class B or ductile iron ASTM A-536 Gr. 65-45-12.
3. The disc shall utilize an on-center shaft and symmetrical design, cast from ductile iron ASTM A536 Gr. 65-45-12. The disc edge shall be stainless steel type 316. Discs shall be retained by pins that extend through the full diameter of the shaft. The pin material shall be the same as the shaft material. Torque plugs or tangential fasteners shall not be allowed. The seat shall be EPDM.
4. The shaft shall be made of ASTM A-564 Type 630 condition H-1150. The shaft seals shall be "V" type packing. Shaft seals shall be of a design allowing replacement without removing the valve shaft. No O-ring or "U" cup packing shall be allowed. The bearing shall be a stainless steel backed teflon material. Bearing

load shall not exceed 1/5 of the compressible strength of the bearing or shaft material.

5. Manual actuators shall be for buried service, packaged full of grease suitable for operating temperatures (40° F). Provide a 2" nut at the actuator enclosed within an adjustable cast iron valve box with a cast iron traffic rated lid as detailed on the drawings.
6. The valve and operator will be blasted and coated with the manufacturer's standard epoxy coating.
7. All bolting shall be corrosion resistant 316 stainless steel.
8. Stacwrap shall be used on all direct-buried valve connections to prevent corrosion of the bolts and hardware.

PART 3 - EXECUTION

3.1 DELIVERY, STORAGE, AND HANDLING

A. Piping shall have plastic end caps installed to prevent contamination until installation in the trench.

B. Unload piping using nylon slings. Do not hook pipe ends.

C. Piping shall be stored on level ground, elevated in such a way that the pipe ends do not lay in water.

D. Store piping in accordance with the manufacturers requirements to prevent damage.

3.2 INSTALLATION

A. Refer to the drawings and specifications for trenching, bedding and backfill. Refer to SAWS Construction Standard 804 – Excavation, Trenching, and Backfill.

B. Make field alterations to the piping in accordance with the manufacture's requirements.

C. Install drains at low points and elsewhere as required for system drainage, where accessible. Install air vents at high points. See Mechanical drawings for acceptable drain and vent configurations.

D. Visually inspect pipe for surface scratches or gouges with depths of 10% or greater of the pipe wall thickness. One foot (1') of piping shall be removed on both sides of the surface scratch or gouge that meet this criteria.

E. Welded Joints

1. General

a. All welding on metal piping systems shall be done using qualified welding procedures and qualified welders and welding operators in accordance with Section IX of the ASME Boiler and Pressure Vessel Code. All welding shall be done according to a process that is compatible with the work being welded and the working conditions. Shielded metal-arc welding (SMAW) shall not be used on work less than 3/16 inch thick.
b. Welding shall be completed using only the following processes:

    1) Shielded Metal Arc Welding (SMAW), also known as "stick" welding. All SMAW procedures shall specify E6010 electrodes for the root pass and E7018 electrodes for all subsequent passes.
    2) Gas Tungsten Arc Welding (GTAW), also known as TIG and Heliarc welding.
    3) Submerged Arc Welding (SAW).

c. Fabrication, installation, inspection, examination and testing shall be in accordance with ANSI/ASME B31.9 as applicable.
d. Backing rings (chill rings) or consumable inserts are not allowed.
e. To the extent practical, weld pipe joints only when ambient temperature is above 0° F.
f. Bevel pipe ends per approved WPS, smooth rough cuts, and clean to remove slag, metal particles, and dirt.
g. Use pipe clamps or tack-weld joints with 1 inch long welds; 4 welds for pipe sizes to 10 inches, 8 welds for pipe sizes 12 inches to 20 inches.
h. Build up welds with stringer-bead pass, followed by hot pass, followed by cover or filler pass. Eliminate valleys at center and edges of each weld. Weld by procedures that will ensure elimination of unsound or un-fused metal, cracks, oxidation, blowholes, and non-metallic inclusions.
i. Do not weld-out piping system imperfections by tack-welding procedures; re-fabricate to comply with requirements.
j. If piping component ends are bored, such boring shall not result in the finished wall thickness after welding less than the minimum design thickness (nominal thickness minus 12.5% manufacturer's tolerance). The inside diameters of piping components to be butt-welded shall be aligned as accurately as is practicable within existing commercial tolerances on diameters, wall thickness and out of roundness. Alignment shall be preserved during welding. The internal misalignment of the ends to be joined shall not exceed 0.0625 inch, without the use of lateral restraints.

2. All slag or flux remaining on the bead of welding shall be completely removed before laying down the next successive bead and at the completion of the weld.
3. Pipe adjacent to joints before and during welding shall be preheated by any suitable method in accordance with the qualified welding procedure and in all cases shall be in accordance with ASME B31.9.

4. Weld Quality

   a. All welds shall have full penetration and complete fusion with a minimum of weld metal protruding on the inside of the pipe.
   b. The finished weld contour shall be uniform, with the toe or edge of the weld merging smoothly into the base material. Butt welds shall have a slight reinforcement build-up gradually from the toe or edge toward the center of the weld.

F. Pre-insulated Piping Field Joints

1. Install insulation and jacketing for field joints in accordance with the manufacturer's requirements after all hydrostatic testing is complete.

3.3 CLEANING, FLUSHING, INSPECTING

A. Flush out piping systems with clean water, before proceeding with required tests. Inspect each run of each system for completion of joints, supports, and accessory items.

B. Flushing and Cleaning

1. The contractor shall meet with the Owner and the Owner's water treatment supplier prior to start of cleaning/flushing to review procedures and also circulation routing through the piping. System-specific chemical/cleaning agent requirements shall be confirmed (where applicable) prior to flushing and cleaning.
2. Ensure that water that meets water quality specifications for hydrotesting will be used to fill and flush the systems. Ensure that backflow prevention is adequate.
3. Temporary strainers shall be installed in the system to collect debris.
4. Temporary pumps and piping shall be furnished and installed by the contractor to circulate through the new system. The new piping shall not be directly connected to the existing system until it has been cleaned. The Owner's designated representatives will make the determination that the system is ready.
5. Refer to 232550 for full flushing and cleaning requirements.

3.4 PRESSURE TESTING

A. Except as otherwise specified herein, all non-boiler external piping shall be hydrostatically tested in accordance with ASME B31.9 Code.

B. Provide temporary equipment for testing, including pump and gages. Test gage(s) shall be installed at the highest elevation in the system to be tested. The gage shall be accurate to within 3 psig and shall be calibrated within six months of the test as recorded on a sticker on the gage. Test piping system before joints are insulated and jacketed.

C. All piping subjected to hydrostatic pressure testing shall utilize approved water supplies furnished by the Owner. Unless otherwise specified or required by the manufacturer's recommendations, hydrotesting shall be accomplished using city water.

D. Steel Pipe Test Pressure

1. The hydrostatic test pressure shall be as defined in ASME B31.9. The design pressures are identified in Section 232113.
2. The test pressure for steel piping shall be 1.5 times the design pressure and continuously maintained for a minimum time of 4 hours and may then be reduced to design pressure and held for such time as may be necessary to conduct the examinations for leakage. Examinations for leakage shall be made of all joints and connections. The piping system shall show no visual evidence of weeping or leaking.
3. The contractor shall repair any leaks and re-test at his own expense.

E. Test Blinds

1. If during the field testing of piping it becomes necessary to insert test blinds in any part of this piping, the contractor shall provide test blinds.
2. Test blinds shall be equipped with a long handle.
3. The contractor shall submit a written description of the location of test blinds before testing.
4. The contractor shall remove all test blinds after testing.

F. Repair piping systems sections which fail required piping test, by disassembly and re-installation, using new materials to extent required to overcome leakage. Do not use chemicals, stop-leak compounds, mastics, or other temporary repair methods.

G. Records

1. The Owner will witness all pressure/hydrotests.
2. Keep accurate, updated records of all hydrostatic testing. The contractor shall submit a final log of all hydrostatic testing for the Owner's records.
3. Maintain a constantly updated listed of the following for all hydrostatic tests.

    a. Date and time of test.
    b. Hydrostatic test pressure.
    c. Piping system tested.
    d. Extent of piping system tested so that it can be clearly identified up to what point a piping system has been tested.
    e. Test results. All failures shall be indicated with the cause explicitly stated.
    f. Signed witnesses of each test which shall be one employee of the contractor and by the Owner.

3.5 EXAMINATION OF WELDS

A. Visually examine pipe welds as required by ASME B31.9. Refer to Section 232113 and the associated Piping Design Standards pressures, temperatures and thicknesses of piping systems. As described below, the contractor shall perform visual examination of welds; however, the Owner will ultrasonically examine all butt welds to the criteria of ASME B31.9. Any failed welds will be repaired or replaced at the contractor's expense.

B. Acceptance Standards

1. The acceptance standards for visual examination shall be as defined in ASME B31.9.
2. In addition, acceptance will also be based on the proper layout, materials, and methods, as specified.

C. Failed Welds

1. Welds not passing visual examination shall be repaired or replaced at no expense to the Owner.
2. Do not begin to repair or replace the weld until the weld report has been submitted to the Owner and the Owner gives approval for repairing the weld with the method that the contractor proposes.

D. Reporting

1. When the independent testing agency is specified to perform the visual examinations, the report of each weld examination shall be submitted to the engineer within three working days of the examination. Reports performed for visual examinations by the contractor are not required to be submitted, but shall be kept available for review at any time by the engineer.
2. Weld reports shall include the following.

    a. Date of weld examination.
    b. Type of examination.
    c. Examiner's name.
    d. Welders' names including all persons who worked on the weld and their work involved.
    e. Piping system.
    f. Weld location.
    g. Weld procedure and materials.
    h. Materials and dimensions of items that were welded.
    i. Visual examination results.

E. Examiners' Qualifications

1. Persons performing visual examinations and evaluating examinations shall be certified according to AWS QC1 whether an employee of the independent testing agency or the contractor.
2. Credentials and certification of all examiners must be submitted and approved prior to an examiner performing the initial examination.

F. Visual Examination Requirements

1. Welds designated for visual examination shall be examined as follows.

    a. Before welding, examination shall be made for compliance with requirements for joint preparation, alignment and fit-up, cleanliness, condition of welding equipment, quality and condition of base and filler materials to be used, and preheat, when required.
    b. During welding, examination shall be made for cracks, conformance to the qualified welding procedure, quality of individual weld passes, interpass temperature, placement and sequencing of individual weld passes, and back gouged surfaces.
    c. After welding, examination shall be made for cracks, contour and finish, bead reinforcement, undercutting, overlap, size of fillet welds, finished weld appearance, weld size, weld length, dimensional accuracy of weldment, and monitor post weld heat treatment.

2. Records of visual examinations must be kept as described in this section.
3. Shop fabricated welds may be examined in the shop prior to arrival at the project site provided all other conditions of this section are satisfied.

END OF SECTION 232113.13

HYDRONIC PIPING SPECIALTIES
23 21 16

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Air-control devices.
   2. Strainers.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product:

   1. Include construction details and material descriptions for hydronic piping specialties.
   2. Include rated capacities, operating characteristics, and furnished specialties and accessories.
   3. Include flow and pressure drop curves based on manufacturer's testing for strainers.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data

1.5 QUALITY ASSURANCE

A. Pipe Welding: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code: Section IX.

B. Safety Valves and Pressure Vessels: Shall bear the appropriate ASME label. Fabricate and stamp air separators and expansion tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

PART 2 - PRODUCTS

2.1 HYDRONIC SPECIALTY VALVES

A. Diaphragm-Operated Safety Valves: ASME labeled.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. AMTROL, Inc.
    b. Apollo Flow Controls; Conbraco Industries, Inc.
    c. Bell & Gossett; a Xylem brand.
    d. WATTS.

2. Body: Bronze or brass.
3. Disc: Glass and carbon-filled PTFE.
4. Seat: Brass.
5. Stem Seals: EPDM O-rings.
6. Diaphragm: EPT.
7. Wetted, Internal Work Parts: Brass and rubber.
8. Inlet Strainer: Stainless steel, removable without system shutdown.
9. Valve Seat and Stem: Noncorrosive.
10. Valve Size, Capacity, and Operating Pressure: Comply with ASME Boiler and Pressure Vessel Code: Section IV, and selected to suit system in which installed, with operating pressure and capacity factory set and field adjustable.

2.2 AIR-CONTROL DEVICES

A. Manual Air Vents:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. AMTROL, Inc.
    b. Apollo Flow Controls; Conbraco Industries, Inc.
    c. Bell & Gossett; a Xylem brand.
    d. TACO Comfort Solutions, Inc.

2. Body: Bronze.

3. Internal Parts: Nonferrous.
4. Operator: Screwdriver or thumbscrew.
5. Inlet Connection: NPS 1/2.
6. Discharge Connection: NPS 1/8.
7. CWP Rating: 150 psig.
8. Maximum Operating Temperature: 225 deg F.

B. Automatic Air Vents:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Armstrong (Basis of Design: Armstrong No. 21AR)
    b. AMTROL, Inc.
    c. Bell & Gossett; a Xylem brand.
2. Body: Bronze or Cast iron.
3. Internal Parts: Stainless Steel
4. Operator: Stainless steel float.
5. Inlet Connection: NPS 3/4.
6. Discharge Connection: NPS 3/4.
7. CWP Rating: 250 psig.
8. Provide shut-off valve to facilitate maintenance of air vent.

2.3 STRAINERS

A. Y-Pattern Strainers:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

    a. Mueller Steam Specialty
    b. Bell & Gossett; Div. of Xylem.
    c. Armstrong Pumps Inc.
    d. Keckly

2. Body: ASTM A126, Class B, cast iron with bolted cover and bottom drain connection.
3. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger.
4. Strainer Screen: Stainless-steel, 40-mesh strainer, or perforated stainless-steel basket.
5. Strainers shall include 3/4” NPT taps upstream and downstream for installation of differential pressure gauge.
6. CWP Rating: 125 psig.

PART 3 - EXECUTION

3.1 VALVE APPLICATIONS

A. Install safety valves at hot-water generators and elsewhere as required by ASME Boiler and Pressure Vessel Code, and as indicated on the drawings. Install drip-pan elbow on safety-valve outlet and pipe without valves to the outdoors; pipe drain to nearest floor drain or as indicated on Drawings. Comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1, for installation requirements.

3.2 HYDRONIC SPECIALTIES INSTALLATION

A. Install manual air vents at high points in piping, at heat-transfer coils, and elsewhere as required for system air venting.

B. Install automatic air vents at high points of system piping in mechanical equipment rooms only, and elsewhere as indicated on the drawings. Install manual vents at heat-transfer coils and elsewhere as required for air venting.

END OF SECTION 232116

HYDRONIC PUMPS
23 21 23

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Separately coupled, vertical in-line centrifugal pumps.
2. Suction diffusers

1.3 DEFINITIONS

A. Buna-N: Nitrile rubber.

B. EPT: Ethylene propylene terpolymer.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of pump. Include certified performance curves and rated capacities, operating characteristics, furnished specialties, final impeller dimensions, and accessories for each type of product indicated. Indicate pump's operating point on curves.

1. Performance curves shall include TDH vs Flow, BHP vs. Flow, NPSHr vs Flow, and are to be computer generated.
2. Performance curves are to be adjusted to the actual nameplate speed on the pump motor: i.e. use 1,785 RPM as the speed if the pump motor is nameplated at that speed. Do not use the standard 1,750 rpm curve.
3. For variable speed pumps, provide curves for minimum speed, 50% speed, 75% speed and 100% speed.
4. Include certified data for each motor type.
5. Lubrication requirements.
6. Seal flush system.
7. Equipment weights.
8. Installation and start up requirements.

B. Shop Drawings: For each pump.

1. Show pump layout and connections.
2. Include setting drawings with templates for installing foundation and anchor bolts and other anchorages.
3. Include diagrams for power, signal, and control wiring.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For pumps to include in emergency, operation, and maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Mechanical Seals: One mechanical seal for each pump lineup.

1.7 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to repair or replace any pump component(s) that fails in materials or workmanship within specified warranty period, including start-up. Warranty shall include all associated labor costs for warranty repairs. Start-up services and labor warranty shall be performed by factory employed service technicians.
1. Manufacturer’s Warranty shall run one year from Substantial Completion.
2. At the end of the manufacturer’s warranty period, provide all equipment maintenance records and reports to Owner.
3. Equipment training shall occur within the Manufacturer’s Warranty period, scheduled at Owner’s discretion.

PART 2 - PRODUCTS

2.1 SEPARATELY COUPLED, VERTICAL IN-LINE CENTRIFUGAL PUMPS

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

1. Armstrong Pumps Inc.
2. Bell & Gossett; Div. of Xylem.
3. Grundfos.

B. Description: Factory-assembled and tested, centrifugal, overhung impeller, separately coupled, in-line pump, as defined in HI 1.1-1.2 and HI 1.3; designed for installation with pump and motor shafts mounted vertically.

C. Construction:

1. Casing: Radially split, cast iron, with threaded gauge tappings at inlet and outlet, replaceable lead-free bronze wear rings, and ASME B16.5, Class 125 flanged connections.
2. Impeller: Statically and dynamically balanced to HI 9.6.4.5, closed double-suction type bronze impeller securely mounted on pump shaft and attached with steel key, and secured with a locking cap screw.
3. Impeller diameter:

    a. Minimum tip to cutwater clearance: 4% for impellers 14 inch in diameter and less; 6% for impellers 16 inch in diameter and greater.
    b. Trim to the maximum impeller size that does not cause an increase in motor size (so that maximum efficiency is achieved).

4. Pump Shaft: Split coupled stainless-steel shaft supported by bearings at both drive and non-drive ends of pump.
5. Seal: Mechanical seal consisting of carbon rotating ring against a ceramic seat held by a stainless-steel spring, and EPR bellows and gasket. Include water slinger on shaft between motor and seal. Provide factory installed flush line with manual vent.

    a. The seal shall provide continuous venting and lubrication of the seal chamber by re-circulating fluid from the seal chamber to the pump suction. Vent and lubrication tubing shall be stainless steel, provided with an isolation valve at nozzle connections, and installed free of slags or excessive bends.
    b. Provide John Crane Type 1B or approved equal.

6. Bearings: Ball type, grease lubricated and locked to shaft with positive locks, sized to withstand any axial thrust loads. Each bearing housing is to be affixed to the casing to insure positive alignment.
7. Lead-free 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.

D. Base, Coupling, and Guard: Coupling shall be rigid spacer type constructed of high tensile aluminum. Design coupling for easy removal to allow servicing of mechanical seal without disturbing pump or motor. Coupling and exposed rotating components of the pump and motor shall be protected by an OSHA approved guard.

E. Motor: Motor shall be non-overloading of the horsepower across the entire curve and speed shown in the pump schedule. Pump shall be flexible coupled to the motor.

1. Motors installed indoors:

    a. Enclosure: Open, dripproof or TEFC.
    b. Enclosure Materials: Rolled steel.
    c. Motor Bearings: Grease-lubricated ball bearings.
    d. Efficiency: Premium efficient.

2. Motors Used with Variable-Frequency Controllers: Ratings, characteristics, and features coordinated with and approved by controller manufacturer.

    a. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width-modulated inverters.
    b. Inverter-Duty Motors: Class B temperature rise; Class H insulation.
    c. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.
    d. Provide shaft mounted static discharge dissipation ring with conductive microfibers or provide electrically insulated ceramic bearings.

2.2 PUMP SPECIALTY FITTINGS

A. Suction Diffuser:

1. Angle pattern, 175-psig pressure rating, cast or ductile-iron body and end cap, pump-inlet fitting; with bronze startup and bronze or stainless-steel permanent strainers; bronze or stainless-steel straightening vanes; drain plug; and factory-fabricated support.
2. Provide pad on bottom of suction diffuser to accept pipe stanchion or adjustable foot. Stanchion/foot location shall be directly below the inlet pipe centerline.
3. Suction diffusers shall be Bell & Gossett Suction Diffuser Plus, Mueller Steam Specialty Model 1011 or 1012, Grundfos SD, or Armstrong Model SG.

B. Large Capacity Suction Diffuser:

1. Large capacity suction diffusers for pipe inlet sizes 14 inches and larger shall consist of an elbow type ductile iron body with exit vanes, cast iron cover, integral Class 125 flanged pump suction outlet connection, and a Class 125 flanged inlet connection. Suction diffuser shall also include 1/4" NPT gauge taps at the inlet and outlet, a 1 1/2" blowdown connection, a pipe support leg located to assure no movement between the pump and support base, a stainless-steel diffuser/strainer assembly and a replaceable startup strainer. O-rings for cover shall be Buna N. Suction diffusers shall be suitable for 175 psig at 350 deg. F and 2 psig pressure drop when operating at rated flow with a clean screen.
2. Large capacity suction diffusers shall be Double Suction Diffuser as manufactured by Flow Conditioning Corporation or approved equal.

2.3 NAMEPLATES:

A. Affix an embossed type 316 SS metal nameplate, 16-gauge minimum thickness to each pump indicating as a minimum: rated GPM and TDH, pump model and size, actual impeller diameter, BHP, serial number, casing, and impeller materials of construction.

PART 3 - EXECUTION

3.1 DELIVERY, STORAGE, AND HANDLING

A. Manufacturer's Preparation for Shipping: Clean flanges and exposed machined metal surfaces and treat with anticorrosion compound after assembly and testing. Protect flanges, pipe openings, and nozzles with wooden flange covers or with screwed-in plugs.

B. All pumps shall be tagged with equipment tags per the drawing schedule prior to being shipped to the field. Include design flow and head on nameplate.

C. Store pumps in dry location.

D. Retain protective covers for flanges and protective coatings during storage.

E. Protect bearings and couplings against damage from sand, grit, and other foreign matter.

F. Comply with pump manufacturer's written rigging instructions.

3.2 EXAMINATION

A. Examine equipment foundations and anchor-bolt locations for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for piping systems to verify actual locations of piping connections before pump installation.

C. Examine foundations and inertia bases for suitable conditions where pumps are to be installed.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.3 PUMP INSTALLATION

A. Comply with HI 1.4.

B. Install pumps to provide access for periodic maintenance including removing motors, impellers, couplings, and accessories.

C. Equipment Mounting – Base-Mounted Pump:

1. Install base-mounted pumps on cast-in-place concrete equipment bases.
2. Comply with manufacturer's recommendations and ASHRAE guidelines for vibration isolation.
3. Independently support pumps and piping so weight of piping is not supported by pumps and weight of pumps is not supported by piping.

D. Equipment Mounting – Hanger or Pipe-Supported Pump:

1. Install vertical in-line pumps supported from adjoining piping with continuous-thread hanger rods and spring hangers of size required to support weight of vertical in-line pumps.
2. Comply with requirements for hangers and supports specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."
3. Comply with manufacturer's recommendations and ASHRAE guidelines for vibration isolation.

3.4 ALIGNMENT

A. Engage a factory-authorized service representative to perform alignment service.

B. Comply with requirements in Hydronics Institute standards for alignment of pump and motor shaft.

C. Comply with pump and coupling manufacturers' written instructions.

D. After alignment is correct, tighten foundation bolts evenly but not too firmly. Completely fill baseplate with nonshrink, nonmetallic grout while metal blocks and shims or wedges are in place. After grout has cured, fully tighten foundation bolts.

3.5 CONNECTIONS

A. Comply with requirements for piping specified in Section 232113 "Hydronic Piping."

B. Where installing piping adjacent to pump, allow space for service and maintenance.

C. Connect piping and accessories to pumps as shown on the Contract Drawings.

D. Install pressure gages on pump suction and discharge or at integral pressure-gage tapping, or install single gage with multiple-input selector valve.

E. Ground equipment and connect wiring per Division 26.

3.6 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.
2. Check piping connections for tightness.
3. Clean strainers on suction piping.
4. Perform the following startup checks for each pump before starting:

    a. Verify bearing lubrication.
    b. Verify that pump is free to rotate by hand and that pump for handling hot liquid is free to rotate with pump hot and cold. If pump is bound or drags, do not operate until cause of trouble is determined and corrected.
    c. Verify that pump is rotating in the correct direction.

5. Prime pump by opening suction valves and closing drains, and prepare pump for operation.
6. Start motor.
7. Open discharge valve slowly.

3.7 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain hydronic pumps.

END OF SECTION 232123

FLUSHING, CLEANING, AND PASSIVATING CHILLED WATER SYSTEMS
23 25 50

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. This section includes the following Work:

1. Flushing, cleaning, and passivating the mechanical systems following pressure testing, and prior to start-up. All work shall be supervised by a Chemical Cleaning Subcontractor.

B. Related Sections:

1. Section 23 21 13, Hydronic Piping
2. Section 23 21 13.13, Underground Hydronic Piping.

1.03 PERFORMANCE REQUIREMENTS

A. Purpose of Flushing: To remove all loose dirt, mill scale, metal chips, weld beads, rust and like deleterious substances without damage to the system or components.

B. Purpose of Cleaning: To remove adherent dirt (organic soils), oil, grease (Hydrocarbons), welding or soldering flux, mill varnish, piping compounds, and rust not removed during the initial flushing without chemical or mechanical damage to any system components. Removal of tightly adherent mill scale is not required.

C. Purpose of Passivation: To prepare metals in the system to minimize their tendency for corrosion. Can occur concurrently with Cleaning.

1.04 SUBMITTALS

A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories.

B. Shop Drawings: Pretreatment and chemical treatment equipment showing tanks, maintenance space required, and piping connections to systems. Include plans, elevations, sections, details, and attachments to other work.

C. Personnel: Provide resumes of the company performing the Work, the person responsible for developing the procedures, and the supervisory personnel who will direct the flushing, passivating of the systems in the field. The resumes shall include the relevant experience specified including actual projects by name, location, and owner, and shall include references who can be contacted to verify experience and performance.

D. Procedures:

1. Provide written procedures, approved by the Owner's water treatment consultant, that outline actual procedures for flushing, cleaning, and passivating the piping systems. Include marked up flow diagrams, valve designations, and fill and dumping locations. Designate the source of water and the dump locations. Designate an appropriate temporary pump. Estimate water quantities and system volume, concentrations of chemicals, and quantities of chemicals to be used.
2. Include in the procedures, pH and concentration limits expected to be achieved for flushing, including before, after, and intermediate numbers. Outline methods of testing.
3. Include lists of personnel protective equipment that must be used.
4. Include test methods, apparatus, and equipment that will be used.

E. Product Data: Provide MSDS (Material Safety Data Sheets) sheets for all chemicals that will be used.

F. Field quality-control test reports.

1.05 QUALITY ASSURANCE

A. Chemical Cleaning Subcontractor: The Chemical Cleaning Subcontractor will provide supervisory type work to direct the flushing, cleaning, and passivating of the mechanical work.

1. The Chemical Cleaning Subcontractor shall produce evidence that the company providing the Work has performed such work for at least 10 years on at least 20 comparable projects.
   a. The actual person providing on-site assistance and supervising the Work shall have a minimum of 5 years' experience with performing the type of work outlined in this section on at least 10 comparable projects.

b. The Chemical Cleaning Subcontractor shall provide a person who is familiar with water chemistry through education or experience, who can coordinate with Owner's water treatment consultant. This person shall have at least 10 years' experience on at least 20 comparable projects. He shall familiarize himself with the Project and then provide recommendations for actual chemicals used, provide written procedures for performing the Work, and shall assist in testing the water at various stages.

2. Owner's Chemical Cleaning Subcontractor:
   a. Chem-Aqua
      2727 Chemsearch Blvd.
      Irving, Texas, 75062
   b. Contacts
      1) Kevin Kennedy
         Regional Manager
         Kevin.Kennedy@chemaqua.com
         (830) 406-1201

      2) Scott Talley
         District Manager
         Scott.Talley@chemaqua.com
         (318) 272-9024

1.06 DELIVERY, STORAGE, AND HANDLING

A. The Contractor shall provide Owner approved temporary "Chemical Containment Systems" for the on-site storage of, and use of, all chemicals and temporary pumping systems required for completion of this Work. Submit proposed containment system for approval.

B. Approval of, and installation of, the proposed system shall be completed by the Contractor prior to shipping any chemicals to the Site.

PART 2 PRODUCTS

2.01 CLEANING CHEMICALS

A. Use normally prepared chemicals designed specifically for use in cleaning out chilled water piping, as appropriate for the pipe material, and as recommended by the Chemical Cleaning Subcontractor.

2.02 CHEMICALS- CLEANING AND PASSIVATING

A. Chemicals shall be as recommended by the Chemical Cleaning Subcontractor and reviewed by the Owner. Chemicals shall be in accordance with Chemical Cleaning Subcontractor's instructions, and shall be compatible with piping

system components and connected equipment, and capable of attaining the required pipe and water quality.

B. Chemical Cleaning Subcontractor must select, manufacture, and deliver chemicals for cleaning and passivating water-side surfaces prior to implementation of the regular water treatment program and Mechanical system startup. Chemical Cleaning Subcontractor must be available for consulting and testing during the contractor's application of these chemicals in the chilled water loops. Chemicals shall remove mill scale, oil, and greases as well as passivate surfaces with a protective oxide film.

1. Alkaline cleaner/penetrant/dispersant chemical. This product must be in liquid form and capable of removing mill scale, oils, greases, debris, and byproducts of construction. It shall be fed at the vendor's recommended dosage rate based on the volumes of the systems treated.
2. Passivating chemical. This product must be in liquid poly-phosphate form and capable of laying down a protective oxide film on metal surfaces after treatment with the cleaning chemical. It shall be fed at the vendor's recommended dosage rate based on the volumes of the systems treated.

C. All residuals of the cleaning and passivating chemicals must be completely removed from the piping system prior to system startup.

PART 3 EXECUTION

3.01 PLANNING BY THE CHEMICAL CLEANING SUBCONTRACTOR

A. During the initial stages of the Contract, the Chemical Cleaning Subcontractor shall review the Drawings and meet with the Construction Manager to develop a plan for flushing, cleaning, and passivating the piping systems on this Project.

B. Develop and submit flushing plans and procedures as early as practical, and prior to completion of construction. Coordinate with the Owner and SAWS personnel for any proposed iterations that would affect chilled water or any plant equipment or distribution piping

C. Once a preliminary plan is developed, the Chemical Cleaning Subcontractor shall coordinate with the Owner to determine if there are any restrictions on dumping the flushing and cleaning waters, based on quantities and chemical concentrations that would be expected.

D. The Chemical Cleaning Subcontractor shall then develop the final flushing, cleaning, and passivating plan. The plan shall include proposed means and methods, quantities of water and chemicals required, water sources, dumping locations, MSDS sheets, personnel protection equipment required, testing apparatus required, etc. The plan shall provide an abbreviated version of each procedure with the major headings. This abbreviated version shall serve as a

checklist and shall include pertinent readings (pH, concentration, temperature, start and stop circulation times, etc.) and shall be include locations for sign-off by the Chemical Cleaning Contractor, the Construction Manager, and SAWS personnel.

3.02 COORDINATION OF WORK – GENERAL

A. The flushing, cleaning, and passivation work shall be planned by an officer of the Chemical Cleaning Subcontractor's company. The supervision of the flushing, cleaning, and passivation work in the field shall be performed by supervisory filed representative employed by the Chemical Cleaning Subcontractor. The officer of the Chemical Cleaning Subcontractor's company shall perform the planning of the flushing, cleaning, and passivation work and shall be available during the actual execution of the Work for discussion about any problem matters.

B. Provide temporary and permanent piping, hoses, equipment, and materials required for flushing work. Where required, the Contractor will provide cross-connects between the supply and return laterals, mains, branch lines, and equipment connections to permit flushing. Following flushing, the Contractor will be responsible for removing temporary piping and installing the final connections between the new and existing piping.

C. The Contractor will be responsible for operating valves that are part of the new construction as directed by the Chemical Cleaning Contractor in a coordinated effort to perform this task.

D. If equipment and piping systems are not properly cleaned and flushed, the Contractor shall pay for resultant damage, necessary cleaning and flushing of systems to which connection was made, and subsequent inspection, at no increase in Contract Sum.

E. Complete the flushing of the piping mains first and then flush branch piping.

F. Submit for approval proposed sources of flushing water and means of disposal of flushing water. Storage of the water may be required. Dispose of flushing water in an approved manner.

G. Generally, piping shall be thoroughly flushed with water as required to ensure removal of dirt, scale, oil, cuttings, and other foreign matter. After removal and reinstallation of valves and strainer screens, verify cleanliness of system by flowing water through 25-micron filter media. This operation will be completed at each main equipment supply and return drop (i.e., Heat Exchangers or Users). Minimal levels of particles shall be visible on the filter media. Allow for a 5-gallon sample.

H. Additional Considerations:

1. All piping must be thoroughly flushed before turnover to operation and before supplying chilled water to customers. Note that chilled water plant equipment (chillers, pumps, etc.) and ETS equipment (plate heat exchangers, valves, etc.) can be sensitive to large and small foreign material. Ensure stagnant deadlegs are adequately flushed and cleaned, as well any existing or new piping inaccessible by the flushing connections provided.
2. Consider utilizing temporary flushing, dumping, filtering, and recirculating connections at the ends of new piping and in phases as necessary.
3. Water temperatures shall be monitored to ensure system design temperatures are not exceeded.
4. Coordinate with the Owner and SAWS personnel for initial operations after flushing is complete, particularly for the initial chilled water recirculated to the plant.
5. For systems not going into service within 14 days after the completion of final flushing, follow the Chemical Cleaning Subcontractor's recommendations for system lay-up and/or circulation.

3.03 GENERAL INFORMATION – FLUSHING, CLEANING, AND DISPOSAL

A. The Contractor shall flush, clean, passivate, and chemically treat all new piping. The Contractor shall hire a Chemical Cleaning Subcontractor to plan, supervise, and furnish chemicals for performing the flushing, cleaning, passivating, and chemically treating the water.

B. All Cleaning Tests shall be witnessed by Owner. The Construction Manager and the Owner's Project Manager shall be notified one week prior to conducting any tests.

C. Dry chemicals shall not be placed in any system. All chemicals shall first be thoroughly dissolved in water, strained, then injected into each system.

D. "Flushing" means the use of non-potable city water on a once through basis.

E. "Cleaning" means the repeated re-circulation of water containing chemical cleaning compounds.

F. The Contractor shall coordinate the flushing and cleaning activities with the Chemical Cleaning Subcontractor field representative, and provide all labor, temporary strainers, spool pieces, hose connections, pumps, chemical feed pumps, injection manifolds, and any other items as required to complete the approved procedure.

G. The Contractor shall provide Owner approved temporary "Chemical Containment Systems" for the on-site storage of, and use of, all chemicals and temporary pumping systems required for completion of this work. Submit proposed

containment system for approval. Approval of, and installation of, the proposed system shall be completed by the Contractor prior to shipping any chemicals to the Site.

H. Dump all flushing water used for the cleaning, final flushing, and metal passivation stages into locations that are approved for accepting their disposal. Dilute discharge if necessary to meet chemical limits established by the local sanitary sewer authority. For the purposes of this bid, assume the waters can be dumped into the sanitary sewer system. If, during the planning stage, it is apparent that the water must be trucked off-site, prepare documentation for change order to perform this work. Include additional labor, trucking fees, and disposal fees in the change order, if the change order is required.

I. Confer with, and gain written approval from, the Owner before dumping, or disposing of any liquids into the sanitary sewer system.

J. The Contract price shall include all costs associated with filling, cleaning, flushing, chemicals, unloading, preparation of affidavits, and MSDS, including all material, labor, reproduction fees, equipment, etc. for performing all of the specified requirements.

K. Initial Flushing:

1. Purpose: To remove all loose dirt, mill scale, metal chips, weld beads, and rust without damage to the system or components.
2. Bypass equipment and/or accessories, unless acceptable means of protection are provided or the component was factory cleaned.
3. Isolate, remove, or protect all system components, including pumps and heat exchangers, and any other components which may be damaged.
4. Remove plugs, caps, spool pieces and components to facilitate early discharge from the system.
5. Clean system storage vessels, compression tanks, expansion tanks, sumps, and basins.
6. Open and close valves during flushing to remove debris from valve bodies and seats.
7. Sectionalize the system in order to obtain a minimum debris carrying velocity determined by the flushing contractor but not less than 5 ft./sec. in all sizes of piping.
8. Connect dead-end supply and return headers and the like, as necessary to provide for proper cleaning, flushing, and passivation of the entire system.
9. Implement means to flush all stagnant lines (deadlegs) and otherwise inaccessible segments thoroughly, including at connections to existing piping, as part of the overall flushing process prior to turnover for service.
10. Install temporary strainers or screens where necessary, to protect downstream equipment and other components.

11. Supply all temporary piping necessary to complete the flushing, cleaning and passivation of the entire system, and connection to all contractor supplied pumps, and chemical mixing and injection systems.
12. Flush system for a minimum of 4 hours, until the water quality is approved by the Chemical Cleaning Subcontractor's field representative, and the Owner.
13. Inspect the system to determine if debris accumulation requires dewatering and cleaning, or continued flushing prior to the next phase of work.
14. Dispose of all flushing water.

L. Cleaning and Passivation:

1. Cleaning Purpose: To remove adherent dirt (organic soils), oil, grease (Hydrocarbons), welding or soldering flux, mill varnish, piping compounds, and rust not removed during the initial flushing without chemical or mechanical damage to any system components. Removal of tightly adherent mill scale is not required.
2. Passivation Purpose: To prepare metals in the system to minimize their tendency for corrosion.
3. Fill the system with clean water and add the Chemical Cleaning Subcontractor's cleaning and passivation chemicals at the recommended dosages. Maintain a minimum flow velocity of 3 ft./sec. through all piping and equipment to be cleaned. Identify and bypass any equipment containing metallurgy that is not compatible with cleaning solutions to avoid permanent damage.
4. Pipe strainers shall be cleaned frequently during the cleaning period to keep the water system velocity at design conditions. Immediately clean all strainers showing pressure drop in excess of 3.0 psig.
5. Air vents shall be frequently checked to ensure air is kept purged from the systems.
6. If building pumps are used to circulate cleaning solution, the mechanical seals must be replaced by the Contractor.
7. Circulate for a minimum of 48 hours, until the water quality is approved by the Chemical Cleaning Subcontractor's field representative, and the Owner.
8. Dispose of all cleaning and passivation water.

M. Final Flushing:

1. Immediately following discharge of cleaning water, and any required disinfection is complete, fill the piping system with clean water. Bleed and feed the system for a minimum of 1 hour or until circulating a minimum of 6 times the system volume, whichever is more stringent.
2. Flush all piping legs and isolated clean equipment.
3. Gently operate all valves to dislodge any debris in the valve body by throttling the velocity.

4. Blowdown all permanent system strainers.
5. When flushing is complete, the conductivity should be approximately equal to the makeup water.
6. After flushing is complete, fill the piping system with clean water and add the Chemical Cleaning Subcontractor's recommended amount of corrosion inhibitor and any other operational chemicals to the system.
7. Restore piping and components that were removed for flushing to their final installed condition as specified in the contract documents.

N. Nitrogen Blanket: For piping that is intended to be connected to at a later date, the isolation valve shall be shut and a nitrogen blanket of 2-5 psig shall be applied to the piping.

1. As an alternative, the contractor may opt to install a circulation loop in lieu of the nitrogen blanket. Refer to SAWS CCS for requirements.

O. Miscellaneous:

1. Close-up system for disinfection (where required) of specified service.
2. Inspect and repair, as required, all permanent equipment used for flushing operations.
3. Remove temporary strainers, temporary screens in strainers and blow down any strainers without temporary start-up screens after systems have been placed into normal operation for not less than 2 weeks.

P. Hand Cleaning:

1. SAWS will permit hand cleaning for certain pipe segments when it is not feasible to clean as part of the overall piping system.
2. Contractor shall request Owner approval for hand cleaning and passivating for each requested pipe segment. The requested pipe segment shall be clearly identified in the Shop Drawing submittals.
    a. If utilizing hand cleaning, only two additional field welds are permitted.
3. Hand Cleaning Procedure:
    a. Contractor to hand clean the approved piping segment with cleaning chemicals and procedures as recommended by the Owner's Chemical Cleaning Subcontractor.
    b. Contractor shall take pictures of each approved pipe segment before and after cleaning.
    c. The Owner's Chemical Cleaning Subcontractor shall provide a report to SAWS that includes the before and after pictures and certifies that the approved pipe segment is flushed and cleaned per their standards.

d. Contractor shall protect the open ends of each approved pipe segment with suitable plastic wrap. The plastic wrap shall remain in place until the pipe segment is installed.

3.04 CONNECTIONS

A. Piping installation requirements are specified in other Division 23, Heating, Ventilating, and Air Conditioning sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to equipment to allow service and maintenance.

3.05 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage the services of a representative from chemical cleaning contractor to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing.

B. Perform tests and inspections and prepare test reports.

C. Tests and Inspections:

1. Inspect field-assembled components and equipment installation, including piping and electrical connections.
2. Inspect piping and components to determine that systems have been cleaned, flushed, and filled with water, and are fully operational before introducing chemicals for water-treatment system.
3. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.

D. Remove and replace malfunctioning units and retest as specified above.

END OF SECTION 232550

HEAT EXCHANGERS FOR HVAC
23 57 00

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes gasketed-plate heat exchangers.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated capacities, operating characteristics, performance data at design conditions, and furnished specialties and accessories.
2. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Equipment room, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Plate-removal space.
2. Structural members to which heat exchangers will be attached.

B. Product Certificates: AHRI Certified label, certified by the AHRI Liquid to Liquid Heat Exchangers Certification Program, based on AHRI Standard 400.

C. Sample Warranty: For manufacturer's warranty.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data.

1.6 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to repair or replace any heat exchanger component(s) that fails in materials or workmanship within specified warranty period, including start-up. Warranty shall include all associated labor costs for warranty repairs. Start-up services and labor warranty shall be performed by factory employed service technicians.

1. Failures include, but are not limited to, the following:

a. Structural failures including heat exchanger and supports.
b. Deterioration of metals, metal finishes, gaskets and other materials beyond normal use.

2. Manufacturer’s Warranty shall run one year from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 GASKETED-PLATE HEAT EXCHANGERS

A. Manufacturers: Subject to compliance with requirements, shall be one of the following:

1. Alfa Laval, Inc (Basis of Design).
2. Tranter
3. Kelvion, Inc.

B. Configuration: Freestanding assembly consisting of frame support, top and bottom carrying and guide bars, fixed and movable end plates, tie rods, individually removable plates, and one-piece gaskets.

C. Construction: Fabricate and label heat exchangers to comply with ASME Boiler and Pressure Vessel Code, Section VIII, "Pressure Vessels," Division 1.

D. Frame:

1. Provide carbon steel frames, cleaned of mill scale, prepared per SSPC-SP1063T primed and painted with two (2) coats of baked epoxy enamel. The frame shall be a single pass design with all inlet and outlet connections on the fixed cover.
2. The fixed and movable covers shall be of a sufficient thickness for design pressure and code requirements and shall have no welded reinforcements or stiffeners.
3. The frame assembly shall be of bolted construction. Welded frame assemblies are not acceptable.
4. The movable cover shall be provided with steel roller bearing for units greater than 50” in height (from bottom of feet) and for units with port sizes 3” and larger. This allows the movable cover to be moved without additional rigging or handling equipment.

5. Provide inspection ports on movable cover with lifting lugs, cleanout taps, and ball valves.
6. The top and bottom carrying and guide bars shall be constructed of carbon steel with two (2) coats of baked epoxy enamel. Where the carrying and guide bars come in contact with the plates, the bars shall be provided with stainless steel plating to prohibit corrosion and facilitate movement of the plates.
7. Provide a minimum of two (2) lifting lugs per frame for units with 6 inch ports and larger, designed for lifting assembled unit's flooded weight.
8. Capacity to accommodate 20 percent additional plates.
9. Painted carbon steel with provisions for anchoring to support.

E. Top and Bottom Carrying and Guide Bars: Painted carbon steel, aluminum, or stainless steel.

1. Fabricate attachment of heat-exchanger carrying and guide bars with reinforcement strong enough to resist heat-exchanger movement during seismic event when heat-exchanger carrying and guide bars are anchored to building structure.

F. End-Plate Material: Painted carbon steel.

G. Tie Rods and Nuts: Steel or stainless steel.

H. Plates

1. Material: 0.019-inch (0.5-mm) thick before stamping; Type 304 stainless steel. Plates shall have herringbone corrugations to provide support to adjacent plates.
2. Each plate shall be pressed from a homogenous metal sheet in one step. Multi-stage pressing is NOT allowed.
3. All plates shall be permanently marked to identify quality and material.
4. All ferrous materials in contact with fluids on the hot and cold sides shall be Type 304 stainless steel.
5. Each heat transfer plate shall have built-in self-aligning system to accurately locate plates in the frame assembly and prevent lateral movement and maintain maximum gasket contact under pressure.
6. Plates shall be reinforced on the upper and lower mounting slots to avoid bending on the plates.
7. Heat transfer plates shall include tapered gasket grooves and shall receive standard IIB finish.

I. Gasket

1. Materials: One-piece molded Nitrile rubber (NRB).
2. Fit around the heat transfer area and the port holes without the need for either glue or adhesive.
3. Gasket shall be permanently marked to identify quality and material.

J. Piping Connections: Factory fabricated of materials compatible with heat-exchanger shell. Attach tappings to shell before testing and labeling.

1. Flanged ends according to ASME B16.5 for steel and stainless-steel flanges and according to ASME B16.24 for copper and copper-alloy flanges.

K. Enclose plates in an OSHA compliant, two-piece 304 stainless-steel removable shroud.

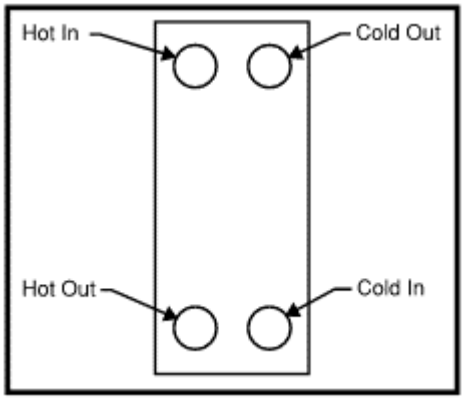
L. Nozzles

1. Provide Type 304 stainless steel lined studded ports for ASME B16.5 flanges on end frames, rated for the design pressure.

M. Bolts

1. Compression bolts shall not require special tools and shall be equipped with lock washers at the movable cover to facilitate opening and closing of a unit from the fixed cover.
2. Compression bolts shall be equipped with captive nuts at the fixed cover and threaded nuts at the removable cover. Welding of the nuts to the closure bolt is prohibited.
3. Compression bolts shall be high tensile strength carbon steel.
4. The fixed and free nuts shall be heavy duty carbon steel.
5. The nuts and washers shall be cadmium plated.
6. The bolts shall be coated with molybdenum grease for rust protection.
7. Provide plastic sleeve to protect bolts.
8. Bolts shall be provided with rolled threads to reduce galling and double-width hex nuts to distribute the load. Ball bearing box washers shall be provided at all critical closing bolts on all units greater than 50” in height.

N. Capacities and Characteristics:
1. See design drawing equipment schedules for design pressure, temperatures, flow rates, and heat transfer capacity.
2. Hot-side and cold-side pressure drop shall not exceed 7.5 psig.
3. Maximum surface margin: 5%.
4. Test pressures:
   a. For 150 psig design pressure, test pressure shall be 195 psig.
   b. For 300 psig design pressure, test pressure shall be 390 psig.
5. Piping Connection Pattern: Facing fixed plate from connection end:



O. Nameplates

1. Each exchanger shall have a stainless-steel nameplate permanently attached to the frame.

   a. The nameplate shall be mounted off the surface of the heat exchanger to permit the application of 2-inch-thick insulation.

   b. Nameplate brackets shall be fabricated from thermally nonconductive materials to eliminate sweating.

   c. The nameplate shall include, as a minimum, the following data stamped on the face of the nameplate:

      1) Project name.
      2) Customer order number.
      3) Equipment designation.
      4) Year manufactured.
      5) Heat transfer coefficient.
      6) Hot and cold side design.

         a) Temperatures.
         b) Working pressures.
         c) Design flow rates.
         d) Pressure differentials at design flow rates.

      7) All information required for plate pack compression.
      8) Model and serial numbers.

2.2 ACCESSORIES

A. Hangers and Supports:

1. Custom, steel supports for mounting on floor.

2. Factory-fabricated steel supports to ensure both horizontal and vertical support of heat exchanger. Comply with requirements in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."

B. Insulation: Enclose all 6 chilled surfaces of heat exchanger with an insulated aluminum removable shroud.

1. Shroud: 1 mm external stucco aluminum sheet.
2. Insulation: 0.05 mm internal aluminum folio with minimum 60 mm thick polyurethane insulation.
3. Weather strip panels to provide vapor tight seal.
4. Stainless steel locking latches.

2.3 SOURCE QUALITY CONTROL

A. Factory Tests: Test and inspect heat exchangers according to ASME Boiler and Pressure Vessel Code, Section VIII, "Pressure Vessels," Division 1. Affix ASME label.

B. Hydrostatically test heat exchangers to test pressure rating before shipment.

C. Heat exchangers will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas for compliance with requirements for installation tolerances and for structural rigidity, strength, anchors, and other conditions affecting performance of heat exchangers.

B. Examine roughing-in for heat-exchanger piping to verify actual locations of piping connections before equipment installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 GASKETED-PLATE HEAT-EXCHANGER INSTALLATION

A. Install gasketed-plate heat exchanger on cast-in-place concrete equipment bases. anchored to structure as indicated on Drawings.

B. Install metal shroud over installed gasketed-plate heat exchanger according to manufacturer's written instructions.

3.3 CONNECTIONS

A. Comply with requirements for piping specified in other Section 232113 "Hydronic Piping" and Section 232116 Hydronic Piping Specialties." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Maintain manufacturer's recommended clearances for plate removal, service, and maintenance.

C. Install piping adjacent to heat exchangers to allow space for service and maintenance of heat exchangers. Arrange piping for easy removal of heat exchangers.

D. Install shutoff valves at heat-exchanger inlet and outlet connections.

E. Install relief valves on heat-exchanger heated-fluid connection and install pipe relief valves, full size of valve connection, to floor drain.

F. Install thermometers on heat-exchanger inlet and outlet piping. Comply with requirements for thermometers specified in Section 230519 "Meters and Gages for HVAC Piping."

G. Install pressure gages on heat-exchanger inlet and outlet piping. Comply with requirements for pressure gages specified in Section 230519 "Meters and Gages for HVAC Piping."

3.4 FIELD QUALITY CONTROL

A. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

B. Heat exchanger will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

3.5 CLEANING

A. After completing system installation, including outlet fitting and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finishes.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain heat exchangers.

END OF SECTION 235700

LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES
26 05 19

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:
   1. Building wires and cables rated 600 V and less.
   2. Connectors, splices, and terminations rated 600 V and less.

1.2 DEFINITIONS

A. EPDM: Ethylene-propylene-diene terpolymer rubber.

B. NBR: Acrylonitrile-butadiene rubber.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Qualification Data: For testing agency.

C. Field quality-control test reports.

1.4 QUALITY ASSURANCE

A. Before electrical circuitry has been energized, perform visual and mechanical inspection of each conductor and cable.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.5 COORDINATION

A. Coordinate layout and installation of cables with other installations. Revise locations and elevations as required to suit field conditions.

PART 2 - PRODUCTS

2.1 CONDUCTORS AND CABLES

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. American Insulated Wire Corp.; a Leviton Company.
2. Okonite.
3. Southwire Company.

B. Copper Conductors: Comply with ICEA S-95-658/NEMA WC 70.

C. Conductor Insulation: Comply with ICEA S-95-658/NEMA WC 70 for Types THHN-THWN, XHHW and SO. Outer cable jacket shall be color coded in accordance with the associated phase it is connected to. Reference Section 260553.

2.2 CONNECTORS AND SPLICES

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. AFC Cable Systems, Inc.
2. Hubbell Power Systems, Inc.
3. O-Z/Gedney; EGS Electrical Group LLC.
4. 3M; Electrical Products Division.
5. Tyco Electronics Corp.

B. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.

PART 3 - EXECUTION

3.1 CONDUCTOR INSULATION AND WIRING METHODS

A. Branch Circuits: Type THHN-THWN, single conductors in raceway.

B. Class 1 Control Circuits: Type THHN-THWN, single conductors in raceway.

C. Class 2 Control Circuits: Type THHN-THWN, single conductors in raceway.

3.2 INSTALLATION OF CONDUCTORS AND CABLES

A. Electrical contractor shall furnish, install, and terminate all conductors and cables unless noted otherwise in the contract documents.

B. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.

C. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.

D. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.

3.3 CONNECTIONS

A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

B. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.

C. Wiring at Outlets: Install conductor at each outlet, with at least 8 inches of slack.

3.4 FIRESTOPPING

A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly.

3.5 FIELD QUALITY CONTROL

A. Tests and Inspections:
   1. Perform visual and mechanical inspection prior to energization.
   2. After energized, verify electrical circuitry functions to meet requirements.

B. Remove and replace malfunctioning units and retest.

END OF SECTION 260519

RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS
26 05 33

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes raceways, fittings, boxes, enclosures, and cabinets for electrical wiring.

1.2 DEFINITIONS

A. EMT: Electrical metallic tubing.

B. EPDM: Ethylene-propylene-diene terpolymer rubber.

C. FMC: Flexible metal conduit.

D. IMC: Intermediate metal conduit.

E. LFMC: Liquidtight flexible metal conduit.

F. NBR: Acrylonitrile-butadiene rubber.

G. RMC: Rigid metallic conduit.

H. RNC: Rigid nonmetallic conduit.

I. Raceway: An enclosed channel of metal or nonmetallic materials designed expressly for holding wires, cables, or busbars, with additional functions as permitted in this *Code*. Raceways include, but are not limited to, rigid metal conduit, rigid nonmetallic conduit, intermediate metal conduit, liquidtight flexible conduit, flexible metallic tubing, flexible metal conduit, electrical nonmetallic tubing, electrical metallic tubing, underfloor raceways, cellular concrete floor raceways, cellular metal floor raceways, surface raceways, wireways, and busways; (as defined by NFPA 70- National Electric Code).

1.3 SUBMITTALS

A. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.

B. Shop Drawings: For custom enclosures and cabinets. Include plans, elevations, sections, and attachment details.

1.4 COORDINATION

A. Coordinate layout and installation of raceways and boxes with other construction elements to ensure adequate headroom, working clearance, and access.

B. Revise locations and elevations as required to suit field coordination.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 METAL CONDUIT AND TUBING

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

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. AFC Cable Systems, Inc.
2. Alflex Inc.
3. Allied Tube & Conduit; a Tyco International Ltd. Co.
4. Anamet Electrical, Inc.; Anaconda Metal Hose.
5. Electri-Flex Co.
6. Manhattan/CDT/Cole-Flex.
7. Maverick Tube Corporation.
8. O-Z Gedney; a unit of General Signal.
9. Wheatland Tube Company.
10. Rob Roy (PVC-RGS)

C. Galvanized Rigid Steel Conduit (RMC):
1. Comply with ANSI C80.1.
2. Material: Mild steel tube with continuous welded seam in accordance with ANSI C80.1, and UL 6.
3. Exterior and Interior protective coating: Metallic zinc applied by hot-dip galvanizing. Apply final coat of transparent zinc chromate to exterior. Exterior

and interior coatings applied to conduit shall afford sufficient flexibility to permit field bending without cracking or flaking.

4. Thread pitch shall conform to ANSI/ASME B1.20.1. Taper shall be 3/4”/ft (62.5 mm/m).
5. Each length of conduit shall have UL listing label.
6. Couplings, unions, and fittings: Threaded-type, galvanized steel.
7. Conduit bodies: Threaded or threadless type, cast metal or malleable iron type with zinc or cadmium coating. Covers shall have solid gaskets and captive screw fasteners.
8. Running thread not acceptable.

D. IMC:

1. Comply with ANSI C80.6.
2. Material: High-grade sheet steel with continuous welded seam.
3. External protective coating: Metallic zinc applied by hot-dip galvanizing or electro-galvanizing. Coating shall not flake or crack when conduit is bent. Internal coating of enamel or similar material resulting in smooth surface.
4. Fittings: Threaded or threadless type, galvanized steel or malleable iron.
5. Conduit bodies: Threaded-type, cast metal, or malleable-iron type, with zinc or cadmium coating. Covers shall have solid gaskets and captive screw fasteners.
6. Running thread not acceptable.

E. EMT:

1. Comply with ANSI C80.3.
2. Material: Hot-dipped galvanized, high-grade steel with continuously welded seam.
3. External protective coating: Metallic zinc applied by hot-dip galvanizing or electro-galvanizing. Coating shall not flake or crack when conduit is bent.
4. Internal coating: Baked enamel or similar compound resulting in smooth surface.
5. Fittings: Rust-resistant steel compression type. Connectors shall have insulated insert in throat. Die-cast aluminum material, and indent or set screw type, are not acceptable.
6. Conduit bodies: Malleable iron for use with compression type fittings. Set screw type not acceptable.

F. FMC:

1. Material: Galvanized mild steel.
2. Construction: One continuous length of steel strip of uniform weight and thickness and shaped in interlocking convolutions; fabrication shall result in smooth interior and exterior surfaces, reduced or full wall.
3. Fittings: Cadmium-plated steel, malleable iron, or zinc alloy. Screw in type, 3/4” (19 mm) shall have high-density polypropylene liners.

G. LFMC: Material:

1. Mild steel, galvanized.

2. Construction: One continuous length steel strip of uniform weight and thickness and shaped in interlocking convolutions; fabrication shall result in smooth interior surface.
3. External coating: Provide outer jacket of tough extruded polyvinyl. Jacket shall be positively locked to steel core and be sunlight resistant and listed as oil resistant.
4. Continuous integral grounding strip: Required in sizes 1-1/4" (31 mm) and smaller. Ground wire shall be required for larger sizes.
5. Fittings: Cadmium or zinc-plated steel or malleable iron. Compression type with tapered hub and synthetic rubber gasket and ground ferrule for making positive ground contact with steel core, designed to prevent outer jacket from pulling away from steel core. Connectors shall have insulated insert in throat. Suitable for grounding through 1-1/4" (31 mm) trade size, provide ground wire lug for sizes 1-1/2" (38 mm) and larger.

2.2 METAL WIREWAYS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following or approved equivalent:
   1. Cooper B-Line, Inc.
   2. Hoffman.
   3. Square D; Schneider Electric.

B. Description: Sheet metal sized and shaped per NEC, NEMA 250, Type 3R, unless otherwise indicated.

C. Fittings and Accessories: Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.

D. Wireway Covers: Hinged type.

E. Finish: Manufacturer's standard enamel finish.

2.3 BOXES, ENCLOSURES, AND CABINETS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following or approved equivalent:
   1. Cooper Crouse-Hinds; Div. of Cooper Industries, Inc.
   2. EGS/Appleton Electric.
   3. Erickson Electrical Equipment Company.
   4. Hoffman.
   5. Hubbell Incorporated; Killark Electric Manufacturing Co. Division.
   6. O-Z/Gedney; a unit of General Signal.
   7. RACO; a Hubbell Company.

8. Robroy Industries, Inc.; Enclosure Division.
9. Scott Fetzer Co.; Adalet Division.
10. Spring City Electrical Manufacturing Company.
11. Thomas & Betts Corporation.
12. Walker Systems, Inc.; Wiremold Company (The).
13. Woodhead, Daniel Company; Woodhead Industries, Inc. Subsidiary.

B. Sheet Metal Outlet and Device Boxes: NEMA OS 1.

C. Cast-Metal Outlet and Device Boxes: NEMA FB 1, ferrous alloy or aluminum, Type FD, with gasketed cover.

D. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.

E. Cast-Metal Access, Pull, and Junction Boxes: NEMA FB 1, galvanized, cast iron with gasketed cover.

F. Hinged-Cover Enclosures: Continuous-hinge cover with flush latch, unless otherwise indicated.
1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
2. Nonmetallic Enclosures: Plastic finished inside with radio-frequency-resistant paint.
3. Coordinate NEMA ratings with application specifications in Part 3 of this section.

G. Cabinets:
1. Steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
2. Hinged door in front cover with flush latch and concealed hinge.
3. Key latch to match panelboards.
4. Metal barriers to separate wiring of different systems and voltage.
5. Accessory feet where required for freestanding equipment.
6. Coordinate NEMA ratings with application specifications in Part 3 of this section.

PART 3 - EXECUTION

3.1 RACEWAY APPLICATION

A. Indoor Applications: Apply raceway products as specified below, unless otherwise indicated:
1. Exposed, Not Subject to Physical Damage: EMT (above 6’ AFF in mech rooms)
2. Exposed Subject to Severe Physical Damage: (RMC) Galvanized rigid steel conduit.

3. Corrosive Areas: PVC Coated Galvanized Rigid Steel Conduit.
4. Concealed in Ceilings and Interior Walls and Partitions: EMT.
5. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC
6. Damp or Wet Locations: (RMC) Galvanized rigid steel conduit.
7. Boxes and Enclosures: NEMA 250, Type 1, for use in control room, restrooms, corridor. Use Type 4 or 4X, stainless steel, in plant areas, damp or wet locations, or corrosive environments.

B. Minimum Raceway Size: 3/4-inch (21-mm) trade size.

C. Raceway Fittings: Compatible with raceways and suitable for use and location.
1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings, unless otherwise indicated.
2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with that material. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Use sealant recommended by fitting manufacturer.

D. Install nonferrous conduit or tubing for circuits operating above 60 Hz. Where aluminum raceways are installed for such circuits and pass through concrete, install in nonmetallic sleeve.

E. Do not install aluminum conduits in contact with concrete.

3.2 INSTALLATION

A. Comply with NECA 1 for installation requirements applicable to products specified in Part 2 except where requirements on Drawings or in this Article are stricter.

B. Keep raceways at least 6 inches (150 mm) away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.

C. Horizontal raceway and/or cable runs within walls are not acceptable. Any installation of horizontal raceway and/or cable runs within walls will be completely removed and replaced at contractor’s expense.

D. Complete raceway installation before starting conductor installation.

E. Support raceways to comply with NECA 1 and NECA 101. All supports shall be firmly secured in place. All screws, bolts, nuts, clamps, fitting, and fastening devices shall be made up tight. Hangars and supports shall be suitable for the atmosphere in which they are installed and appropriate for the load they support.

F. Install no more than the equivalent of three (3) 90-degree bends between pull points in any conduit run except for communications conduits, for which fewer bends are allowed.

G. Raceways shall not be embedded within slabs.

H. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors, including conductors smaller than No. 4 AWG.

I. Raceways for Optical Fiber and Communications Cable: Install raceways, metallic and nonmetallic, rigid and flexible, as follows:
   1. 3/4-Inch Trade Size and Smaller: Install raceways in maximum lengths of 50 feet (15 m).
   2. 1-Inch (25-mm) Trade Size and Larger: Install raceways in maximum lengths of 75 feet (23 m).
   3. Install with a maximum of two 90-degree bends or equivalent for each length of raceway unless Drawings show stricter requirements. Separate lengths with pull or junction boxes or terminations at distribution frames or cabinets where necessary to comply with these requirements.

J. Install raceway sealing fittings at suitable, approved, and accessible locations and fill them with listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings at the following points:
   1. Where conduits pass from warm to cold locations.
   2. Where otherwise required by NFPA 70.

K. Expansion-Joint Fittings: Install in each run of aboveground conduit that is located where environmental temperature change may exceed 30 deg F (-1 deg C), and that has straight-run length that exceeds 25 feet (7.6 m).
   1. Install expansion-joint fittings for each of the following locations, and provide type and quantity of fittings that accommodate temperature change listed for location:
      a. Indoor Spaces: Connected with the Outdoors without Physical Separation: 125 deg F (52 deg C) temperature change.
      b. Indoor Spaces: Connected across all structural expansion joints for all conduits 1” and larger.
   2. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per deg F (0.06 mm per meter of length of straight run per deg C) of temperature change.
   3. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at the time of installation.

L. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall.

M. All boxes and enclosures, including but not limited to junction, splice, pull, and device mounting boxes, comprising a raceway system shall be supported independently from the conduits. The utilization of conduit, cable tray or any other raceway system component as a supporting means is not permitted and will be removed and replaced with proper materials and methods at Contractor's expense.

N. All boxes and enclosures, including but not limited to junction, splice, pull, and device mounting boxes, comprising a raceway system shall be installed in an accessible location in accordance with the NEC, OSHA, and Owner Safety Guidelines. Any box or enclosure installation not conforming to this guideline shall be relocated at Contractor's expense.

O. All raceway boxes for SAWS systems shall be spot painted blue or labeled "SAWS" for identification.

3.3 FIRESTOPPING

A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies.

3.4 PROTECTION

A. Provide final protection and maintain conditions that ensure coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.
   1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
   2. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION 260533