

Chilled water is centrally produced and distributed throughout the campus, and this district cooling system shall be utilized wherever possible. The district cooling system is comprised of four major subsystems; the production system, the distribution system, the building bridge system, and the building cooling system. The Designer responsible for connecting to this system is primarily concerned with the last two subsystems (See STANDARD DETAILS - Chilled Water Building Interface). Designer shall provide all necessary information in specifications and drawing so that contractor may provide and install all instrumentation and control valves as described in this guideline.

Building System - Generally

The building system includes all chilled water piping in the building; the chilled water pump and all cooling coils, heat exchangers and other equipment using chilled water. The Designer must consider the following when designing the building chilled water systems.

The maximum allowable elevation of chilled water piping in the building is 565 feet above sea level and not less than 350 feet above sea level.

Designer must calculate chilled water static plus dynamic head for each project and determine if pressure limits of the chilled water system are exceeded. Buildings that require higher or lower elevations or higher heads must have plate and frame heat exchangers. Plate and frame heat exchangers must have the flow regulated on the primary (or supply) side of the heat exchanger by means of a properly sized control valve. The temperature sensor must be located on the secondary side of the heat exchanger in the leaving water line for controlling the chilled water supply temperature to the loads.

The cooling coils and heat exchangers must be designed for variable flow, constant temperature differential. At design conditions these units must have a return temperature of at least 59 degrees F (60 degrees F if a heat exchanger is used) and not require a supply temperature of less than 45 degrees F. The return temperature during low load conditions shall not drop below 55 degrees F. The cooling coil tube velocity at design flow shall not be less than 4 FPS. Provide a leaving chilled water temperature sensor on all heat exchangers (cooling coils) over 10 tons rated cooling capacity.

Chilled water from this system shall not be used for any application where the temperature of the heat exchanger surface in contact with the chilled water exceeds 75 degrees F.

The building pump must be selected for the building system head and flow requirements. A variable volume pump is recommended, particularly in buildings with large cooling loads.

The control valves and control systems on equipment served by the chilled water system must be capable of accurate low load control and close off across the building pump shutoff head.

Use a separate bridge interface system for unusual or special cooling loads. A special load may require an elevated supply temperature, such as process equipment, or may be a critical load in a

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building with only standard AC loads, such as a computer room.

Primary/Secondary Building Bridge System - Generally

By definition a primary secondary bridge connection exists when the primary circuit (distribution mains) is connected to the secondary circuit (building system) by means of a low pressure loss pipe common to both circuits (see ITT B&G Bulletin Number TEH-775). The correct operation of the district cooling system is dependent on the design and operation of the primary/secondary bridge.

Factors that affect the operation of the primary/secondary bridge are described below.

Flow head loss in distribution mains from production plant to point of connection. This value varies primarily with changes in distribution system load.

Flow head loss in branch lines between the bridge and the mains. This value varies primarily with changes in building system load. Generally the branch piping should be designed with a velocity of 3 to 6 FPS depending on actual length. When determining the flow in the pipe, consider what future loads may be imposed upon it. Use the following schedule to determine branch piping size: (length - total equivalent feet of supply + return runs)

GPM	LENGTH (ft)	PIPE SIZE
0-150	0-400	4"
150-250	0-200	4"
	200-1000	6"
250-600	0-250	6"
	250-1000	8"
600-1000	0-400	8"
	400-1000	10"
1000-1500	0-500	10"
	500-1000	12"
1500-2000	0-800	12"
	800-1200	14"
2000-4000	0-500	14"
	500-1000	16"

The operation of the Bridge Return Temperature Control Valve (TCV-A) is of critical importance to the efficient operation of the district chilled water system. This valve(s) shall be designed to control the temperature and limit the flow of water from the building secondary system to the primary distribution system. The designer must pay particular attention to the installed characteristic of this valve. Several factors related to the above described factors must be considered when specifying this valve.

The valve's specified "control head" or the minimum pressure drop across the valve required for satisfactory operation.

The "building load turndown" that the valve is required to control through the bridge connection.

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This may be 3:1 or as much as 300:1 depending on the type of load.

The “distribution pressure turndown” that the valve is required to work against. This is the lowest and highest pressure differential that the CHW Main will impose across the valve and is independent of the “load turndown”. The distance the bridge is located from the production/distribution plant(s) will influence this variable pressure differential. In the case of a building located near a production plant that can be shut down and connected to another plant in the system, high and low pressure differentials will be imposed at different times. Typical pressures close to the plant vary from 5 to 30 psid and far from the plant they may vary from 2.5 to 10 psid.

The pipe to valve size ratio: This is commonly referred to as the “piping geometry factor”. Simple stated, swaging induces turbulence which changes the valve’s flow capacity and must be accounted for in the sizing equation.

The degree to which the valve will cavitate: Cavitation is a performance limit that fluid properties, pressure drop, and trim design impose upon valve operation.

The designer shall follow these guidelines when specifying this valve:

The Bridge Return Temperature Control Valve (TCV-A) shall have a low sensitivity through the first part of its travel with increasing sensitivity as 100% of travel is approached. This equal percentage characteristic valve shall have an installed characteristic that approaches a linear response as valve travel changes with flow.

The designer will obtain from the Chilled Water Engineer (1) the minimum and maximum differential pressures in the mains at the branch connection to the building, (2) the distribution system static pressure in the mains at the branch connection to the building. These pressures must be assumed by the designer to be independent of building load. TCV-A must control flow from design down to 20% of the smallest unit load (coil, heat exchanger, or group of coils that constitute a minimum unit load) within the range of distribution system differential pressures specified by the Chilled Water Engineer. At the lowest building load and highest distribution system differential pressure, the valve must be at no less than 1% of its full range travel. At design flow and lowest mains differential, the valve must be at no more than 90% of its full range travel. If it is not possible to provide this type of response to changes in load with one valve, the designer may use parallel valves, sequentially controlled. Valve leakage at shut-off shall be no greater than 0.6% of design flow at 30 psid. The valve actuator shall be pneumatically operated and capable of valve shut-off against 50 psi differential.

The designer must specify a control valve for this application. The designer must include in the specifications a Bridge Performance Table and a Bridge Return Temperature Control Valve Table.

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The bridge performance table shall have the following information:

Item 1: Average return temperature from all building loads at design conditions (designer must calculate this value). This average return temperature will be the set point for TCV-A. A return temperature of 59° F or more is preferred for all building loads at design conditions (designer must calculate this value). The supply temperature must not be less than 45° F. A separate interface must be provided if specific equipment needs a lower supply temperature.

Item 2: Total flow for all building loads at design conditions (designer must calculate this value)

Item 3: Distribution system supply temperature (from Chilled Water Engineer)

Item 4: CHW flow in distribution system branch connections to building at design conditions (designer must calculate this value)

Item 5: Pressure differential across the distribution mains at the point where the branch lines to the building are connected (from Chilled Water Engineer)

Item 6: Flow head loss due to piping in the branch lines between the distribution mains and the chilled water bridge bypass tees at design conditions (designer must calculate this value)

Example: **Bridge Performance Table**

Building CHW design return temp	59 degrees F
Building CHW design supply temp	45 degrees F
Building design CHW flow	545 GPM
Distribution system supply temp	42 degrees F
CHW Bridge flow	449 GPM
Press differential at mains	Max: 20 psi Min: 5 psi
Pipe flow resistance from mains to bridge bypass tees at CHW Bridge flow	3 psi

The bridge return temperature control valve table shall have the following information:

Column 1 shall be percent of valve rotation with increments of 0%, 10%, 20%, 30%, 40%, 50%, 60%, 70%, 80%, 90%, 100%

Column 2 shall be the percent of design bridge flow at the rotation indicated in the first column and additional conditions in columns 3-5.

Column 3 shall be the piping pressure loss that develops in the branch lines due to water flow at each increment of valve travel (based on item 7 above)

Column 4 shall be the pressure drop across the control valve

Column 5 shall be the installed valve capacity factor

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Column 6 shall be the manufacturer's specified valve capacity at each increment of rotation.

Column 7 shall be the manufacturer's specified swaging factor when the valve is installed adjacent to one or more reducers at each increment of valve rotation.

Example:

BRIDGE RETURN TEMPERATURE CONTROL VALVE TABLE						
Valve: 4" DeZurik High Performance Butterfly Valve						
Pipe: 6" Schedule 40						
% Valve Rotation	% Bridge Flow	Bridge PSID	Valve PSID	Installed Valve CV	Catalog Valve CV	Swaging Factor
0	0%	0.00	5.00	0	0.00	1.00
10	7%	0.01	4.99	14	14.00	1.00
20	20%	0.05	4.95	38	38.00	1.00
30	35%	0.16	4.84	67	67.00	1.00
40	54%	0.38	4.62	105	105.00	1.00
50	77%	0.78	4.22	158	161.00	0.98
60	99%	1.27	3.73	214	228.00	0.94
70	114%	1.68	3.32	262	285.00	0.92
80	127%	2.09	2.91	312	351.00	0.89
90	138%	2.47	2.53	364	418.00	0.87
100	143%	2.67	2.33	394	475.00	0.83

Summary of Requirements for Chilled Water Bridge Installations

- 1 Bridge controller and flow meter purchased and provided by UNC with funds from project, contact Chilled Water Engineer (919-962-9053) for amount of reserve.**
- 2 Designer must consider highest and lowest points in piping system for building as well as design pump head so as not to exceed static limits of the campus chilled water system. Plate and frame heat exchangers must be used for isolating buildings that exceed these limits.**
- 3 Flow Meter: The mechanical contractor shall install this flow meter in the piping system as specified by the designer. The contractor shall furnish and install flanges for flow meter. Designer must provide Chilled Water with the complete mechanical schedule that lists all cooling loads, the specified coil entering and leaving water temperatures and flow, and common bridge pipe size. This will permit Chilled Water to properly size and order the meter so that it will be on hand when the contractor is ready to install it. Designer shall clearly show the orientation and mounting of the flow element on the construction drawings. The preferred meter installation is in horizontal pipe runs. If the meter must be installed in a vertical run, the flow must come from under the meter so that the cone will not entrap air. For horizontal installation, this meter must be installed in either the three o'clock or nine o'clock positions or a maximum of 45 degrees below these positions. There are NO upstream or downstream straight-run requirements for elbows. The meter must not be installed downstream from a control valve. The meter must not be installed in the highest point of a pipe system.**

A spool piece (supplied by the University) shall be installed by the mechanical contractor in the location of the CHW meter , to be replaced with the CHW meter only after all welding, testing, flushing and cleaning operations are completed.
- 4 The bridge controller, not the BAS, will directly control the pumps whether constant or variable speed. Provide I/O between the variable frequency drive and controller as described above and in the schematics furnished with this document.**
- 5 Contact Chilled Water Engineer to determine if the building is classified as "Standard" or "Critical" before designing chilled water bridge.**
- 6 Contact Chilled Water Engineer for assistance in selecting Bridge Return Temperature Control Valve.**
- 7 Provide cooling coils with leaving chilled water temperature sensors for all loads 10 tons or greater. Minimum design chilled water supply temperature is 45 degrees F for all cooling loads.**
- 8 The bridge return temperature sensor must be located a minimum of seven pipe diameters downstream of the bridge bypass tee. The section of bridge return pipe that includes the bridge bypass connection and the bridge return temperature sensor must be in the same horizontal plane. The bridge return temperature sensor must not be located downstream of the return temperature control valve.**
- 9 Chilled Water shall provide a control panel with terminal strip and a connection diagram to**

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the contractor. The connection diagram will be based on the point list previously provided to Chilled Water by the contractor. The contractor shall mount the panel in a location mutually acceptable to Chilled Water and the contractor. The contractor shall connect all instruments to the terminal strip, calibrate and loop check all instruments. A Chilled Water representative will be on hand to jointly verify the loop check and sign the "Check Out Record" (see section 10.2.f below). Upon successful completion of the loop check, Chilled Water will install the controller, startup, and commission the chilled water bridge system.

10 Provide Isolation Valves as shown on the pipe diagrams in the "Standard Details" pages 1 and 2. This includes a valve in the common building return line so that the building does not have to be drained to service components of the chilled water bridge.

11 Chilled Water Service to the Building:

CHILLED WATER IS NOT ADMITTED TO AN INSTALLATION UNLESS METERING EQUIPMENT IS IN SERVICE. CHILLED WATER IS ONLY ADMITTED TO AN INSTALLATION BY CHILLED WATER PERSONNEL.

1. If chilled water is required to maintain conditions so that "finishes" can be applied the contractor must include in the project schedule the availability of chilled water as a prerequisite.
2. The contractor must keep Chilled Water informed of the progress of this work and provide advance notification when support from Chilled Water is required:
 - a. To turn over a flowmeter spool piece to be installed in the location of the flowmeter until all welding, testing, flushing and cleaning operations are completed.
 - b. To turn over the bridge control panel to the contractor.
 - c. To approve the location of all chilled water interface and metering system instrumentation prior to installation.
 - d. To verify pump/pipe alignment.
 - e. To verify pump/motor alignment. UNC representative will check alignment with his own equipment.
 - f. To witness testing, flushing and cleaning operations.
 - g. To turn over the flow meter to the contractor.
 - h. To install the bridge controller.
 - i. To complete joint Chilled Water/Contractor instrument loop check and sign off. Designer should develop a Check Out Record (COR) to be used for this purpose. The following items must be on this COR sheet:
 - Pump starter command and status circuits operated or VFD I/O circuits tested

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and verified including remote “end of line” pressure differential transmitter(s) at bridge control panel.

- Temperature sensors/cables tested for valid readings at bridge control panel.
- Control valves tested for proper actuation and operation as installed.
- Flow meter installed and tested for proper readings using HART communicator and 4-20 ma meter.

j. To connect the instrumentation to the bridge controller and commission the system.

3. The standard State Construction Contract requires the contractor to pay for utilities used by the building prior to its acceptance by the University, see ARTICLE 40. The project documents must make it clear that Chilled Water is a utility that is subject to this requirement. Contact UNC-CH Utilities for up to date chilled water rates.
4. The contractor must submit a Service Request application to UNC-CH Utilities for new chilled water service. Chilled Water is only admitted to an installation by Chilled Water personnel. This application will initiate the set up of a chilled water account in the name of the contractor and an inspection of the chilled water system in the building to insure that it is ready for use. The chilled water service will not be activated until the following items are complete:
 - a. The building service and chilled water bridge piping are properly flushed, cleaned and installed.
 - b. All pumps, VFD’s, valves and instrumentation that make up the chilled water interface and metering system must meet the Chilled Water Design Guidelines and Specifications and must be properly installed.
 - c. The controls for the chilled water interface and metering system must meet the Chilled Water Design Guidelines and Specifications and must be properly installed.
 - d. The network connection for the chilled water interface and metering system must be installed and fully operational.
 - e. The entire chilled water interface and metering system must be fully commissioned including the communication to the Central Chilled Water Operations Center.

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Primary/Secondary Building Bridge System - Description of Operation

A chilled water bridge system shall fall into one of two categories, depending on the kind of building loads that are served. These categories are: (1) standard loads, (2) critical loads. The “standard loads” category generally includes comfort-cooling applications. The “critical loads” category includes research facilities, their auxiliary equipment, medical facilities with operating rooms, and computer facilities. Refer to diagram in section of STANDARD DETAILS titled “Chilled Water Building Interface”.

Bridge Operation for Standard Loads:

Building and EMCS Interface

Normally open contacts in building control system and/or EMCS contacts (BE), close sending a “cooling required” command to bridge control panel energizing the building chilled water circulation pump. Auxiliary contacts on pump starter energize solenoid air valve SAV-1. Where variable frequency drives are used, the bridge controller will energize the solenoid air valve SAV-1. When the building control system is used to provide this signal, outdoor air temperature, cooling coil valve output, or other parameters may be used to initiate bridge operation/shutdown. Designer shall specify parameter to be used.

Decoupled/Coupled Modes

The normal mode of operation of the chilled water bridge is to “decouple” the building system from the chilled water distribution system. A pump circulates chilled water to the building loads at the required flow and pressure. A temperature control loop, consisting of temperature controller (MC-1), temperature sensor (TS-1), and bridge return temperature control valve (TCV-A), regulates chilled water circulation between the chilled water distribution mains and the building system. The control loop maintains a return water temperature equal to or greater than set point. Set point is determined by the design cooling coil leaving water temperature.

Variable volume pumping shall be under the control of the bridge controller. Provide a differential pressure control loop consisting of a differential pressure controller, (MC-1), differential pressure transmitter(s) (PDT-(zone number)), and a Variable Speed Drive(s) (VSD-(?)). The control loop maintains a differential pressure equal to set point. Set point is determined by the design cooling coil and control valve requirements. The following signals must be provided between the variable frequency drive(s) and the bridge controller:

- (1) 4-20 mA isolated process follower output from bridge controller to drive(s)
- (2) 4-20 mA isolated Hz or % speed input to bridge controller from drive(s)
- (3) Dry contact that is normally closed when the drive is de-energized or in the event of a fault. This dry contact shall be open when the drive is energized and not in fault.
- (4) Where a bypass starter is used, a dry contact to indicate bypass status.

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In the event of pump failure, SAV-1 coil in series with pump starter auxiliary contacts, is de-energized. Where variable frequency drives are used, the bridge controller will de-energize the solenoid air valve SAV-1. The building system is isolated from the distribution mains by the closure of (TCV-A). Manual bypass valves shall be provided for the building chilled water pump and bridge bypass pipe. The bridge may be manually coupled to the CHW distribution mains by closing the bridge bypass valve and opening the pump bypass valve.

Interlocks and metering

BTU metering is available as an output of the MC-1 digital controller. The temperature difference of the distribution supply and return as sensed by TS-1 and TS-3 is multiplied by the flow rate as sensed by FE/FT-1. This value is integrated and becomes a digital output to totalizer NQI-1.

Alarm and control logic for the flow valves, pump(s), and control valve(s) shall be provided by digital input from pump starter auxiliary contacts or VS drive status contacts and building control system load status contacts. Bridge system status and alarm condition shall be provided as digital outputs to the building control system and/or EMCS.

Bridge Operation for Critical Loads:

Building and EMCS Interface

Dry contacts in building control system in series with EMCS contacts (BE), toggle bridge controller between the “coupled” and “decoupled” modes of operation as described below. When building load drops below a predetermined level or in the event of a failure of the bridge controls/pumps, the bridge switches to the “coupled” mode.

Decoupled Mode

Water flow across the bridge interface is controlled by a two position spring-return-to-closed valve (FV-B) in the bridge bypass line, a two-position spring-return-to-open valve (FV-C) in the pump bypass line and a temperature control valve (TCV-A) in the distribution return branch line, and a VFD on the pump. A multi-loop digital controller (MC-1) provides regulatory and discreet control of the bridge system components. The normal mode of operation of the chilled water bridge is to “decouple” the building system from the chilled water distribution system.

In this mode the bridge bypass valve is open, the pump bypass valve is closed, the pump(s) is energized, and the bridge return temperature control valve regulates the flow of water across the bridge interface with the building system. The pump(s) circulates chilled water to the building loads at the required flow and pressure. A temperature control loop, consisting of temperature controller (MC-1), temperature sensor (TS-1), and bridge return temperature control valve (TCV-A), regulates chilled water circulation between the chilled water distribution mains and the building system. The control loop maintains a return water temperature equal to or greater than set point. Set point is determined by the design cooling coil leaving water temperature.

Variable volume pumping shall be under the control of the bridge controller. Provide a differential pressure control loop consisting of a differential pressure controller, (MC-1), differential pressure transmitter(s) (PDT-(zone number), and a Variable Speed Drive(s) (VSD-(?)). The control loop maintains a differential pressure equal to or greater than set point. Set point is determined by the design cooling coil and control valve requirements. The following signals must be provided between the variable frequency drive(s) and the bridge controller:

- (1) 4-20 mA isolated process follower output from bridge controller to drive(s)
- (2) 4-20 mA isolated Hz or % speed input to bridge controller from drive(s)
- (3) dry contact that is normally closed when the drive is de-energized or in the event of a fault. This dry contact shall be open when the drive is energized and not in fault.
- (4) Where a bypass starter is used, a dry contact to indicate bypass status.

Coupled Mode

The mode is activated whenever the building load drops below a predetermined level, upon CHW pump failure, or there is a fault in the bridge control panel. The designer shall provide for a signal from the building control system to switch to this mode under normal operating conditions. This signal shall cause the CHW circulation pumps(s) to stop, pump bypass valve FV-C to open, bridge bypass valve FV-B to close, and bridge return temperature control valve TCV-A to open.

Interlocks and metering

BTU metering is available as an output of the MC-1 digital controller. The temperature difference of the distribution supply and return as sensed by TS-1 and TS-3 is multiplied by the flow rate as sensed by FE/FT-1. This value is integrated and becomes a digital output to totalizer NQI-1.

Alarm and control logic for the flow valves, pump(s), and control valve(s) shall be provided by digital input from pump starter auxiliary contacts or VS drive status contacts and building control system load status contacts. Bridge system status and alarm condition shall be provided as digital outputs to the building control system and/or EMCS.**INSTRUMENT SPECIFICATIONS.**

The following field-mounted devices and functions shall be provided for all applications:

TAG NO. DESCRIPTION

MC-1 Multi loop Digital Controller

All control functions for this system must be performed by a multi-loop controller. This controller will be purchased, programmed and installed in a control panel by Chilled Water Services. The panel will be turned over to the contractor for mounting on a wall near the bridge equipment in a location mutually acceptable to the contractor and the owner. The controller shall be provided with an ethernet connection to the campus network.

TCV-A Temperature Control Valve

For valve sizes 2” and larger use a high performance butterfly control valve with a 60 psi pneumatic diaphragm actuator and positioner capable of receiving a 4-20mA control signal. Actuator shall have a position indicator with pointer and scale showing 0 to 100% rotation or “open” “closed”. Actuator shall be capable of opening and closing valve against 50 psi differential. The valve shall have a wafer style body of carbon steel or 316 ss rated for ANSI class 150 service. The seat material shall be PTFE with titanium or stainless steel backup ring with a full support seat retaining ring nested in the valve body. Disk and shaft shall be 316 Stainless steel construction. Disk to shaft connection shall be non-shear tangential pinning. Disk shall be offset from shaft centerline. The valve shall have upper and lower shaft bearings of a 317 stainless steel carrier and PTFE liner. Shaft seal shall be multiple rings of V-flex style PTFE packing with 316 stainless steel packing ring. Actuator shall be spring to close for standard applications and spring to open for critical applications.

Valves may be oriented with the shaft in the vertical or horizontal plane. When mounted in the vertical plane, the actuator assembly must not be located at the bottom of the pipe. The position indicator must be visible from the ME room floor. There must be sufficient clearance to remove the actuator assembly from the valve. Specify actuator mounting position with valve order. Bench-check valve action and travel limits **before** installation.

Manufacturer type: DeZurik BHP,(valve size in inches),W1,CS,TC,S2-S2-FT-TT*DR-(diaphragm size)-SP60-(spring action),P41-G or approved equal

TS-1,2,3,4 Temperature Sensor Assembly

RTD SENSOR: This spring-loaded type sensor shall be a 100 ohm platinum with three 6” stranded/tinned copper, teflon insulated leads. Sheath shall be 9” long, 316 stainless steel, 0.25 inch diameter. The sensitive portion shall not exceed 1” from the sensor tip (See illustration of sensor assembly in Standard details section of this guideline). The spring loading mechanism shall allow the sensor to be removed from the thermo-well without disconnecting or twisting the sensor/transmitter leads.

PERFORMANCE:

Temperature Span: -50 to 200 degrees C
Temperature Coefficient: .00385 ohm/ohm/deg C
Accuracy: ±.12% at 32 degrees F (class B)

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Conformance: DIN-IEC 751

THERMOWELL: The thermowell shall have 1.75" connection head length with 1/2" FNPT instrument mounting, and 3/4" MNPT process-mount. The insertion depth shall be standard 2.5" length with .5" outside diameter and .26" bore. The thermowell shall be compatible with the specified temperature sensor and be constructed of 316 stainless.

BE Bridge Enable Signal

Contractor shall provide interface between the bridge system control panel and the building system control panel. Contact rated for low level electronic signal loads $\leq 10\text{mA}$ at 24 vdc. This shall be a discreet that will command the bridge controller to switch between "coupled" and "decoupled" modes of operation. This signal may be based on such things as outdoor air change-over, heating/cooling change-over, and/or EMCS signal.

PDT - 1 Differential Pressure Transmitter

Instrument shall provide a linear output signal proportional to process differential pressure (DP) for control of building chilled water pump VSD. Sensor shall be capacitance-type.

The instrument shall be microprocessor based. It shall be fully field configurable via the Highway Addressable Remote Transmitter (HART) communication protocol from the controller card.

- Diaphragm Material: Hastelloy
- Fill Fluid: Silicone
- Process Connection: 1/2" Stainless Steel
- Power Supply Voltage: 13 – 35VDC unregulated
- Output Signal: 4-20 maDC
- Damping: Adjustable damping with minimum of 0.2 seconds
- Over Pressure: Minimum overpressure rating shall be 1500 psig or twice the maximum Sensor range which ever is greater
- Operating Temperature: -20 to +180 degrees F
- Minimum Enclosure: NEMA 4
- Performance: Overall performance 0.25% of span for +/- 50degF and +/- 1000psi line and 1:1-5:1 rangedown
 - Zero Zero control shall be continuously adjustable between -50% and 100% of upper range limit. Total calibrated span and zero adjustment cannot exceed upper range limit. Zero and span shall be independently field adjustable with no interaction.
 - Accuracy: $\pm 0.1\%$ of calibrated span, including effects of linearity, hysteresis, repeatability dead band.
 - Stability: $\pm 0.25\%$ of upper range limit for five years.
 - Power Supply Effect: Less than 0.005% of calibrated span per volt.
 - RFI Effect: +/-0.1% of span from 20 to 1000MHZ, and for field strength up to 30 V/m

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Local Indicator: Not required

Hazardous Area Classifications: Not required

Range: 0-10" water column to 0-1000" water column.
Manufacturer: Rosemount, Toshiba, Siemens, Yokogawa, or approved equal.

Electrical Interlocks for Pump(s)

The contractor shall provide all interfaces between starter or variable speed drive and bridge control panel. Contacts shall be rated for low level electronic signal loads. $\leq 10\text{mA}$ at 24vdc. This shall include a circuit to start and stop the pump(s) and an isolated circuit for pump(s) status indication.

Instrumentation Cables

Control cable type: Alpha no. 2421C or Belden no. 8760, 2-conductor twisted, 18 gage, foil shield, PVC jacket.

RTD Temperature Sensors: Alpha no. 2403C or Belden no. 8771, 3-conductor twisted, 22 gage, foil shield, PVC jacket

The following additional field-mounted devices and functions shall be provided for Critical applications:

FV-B, FV-C Flow Valves

Butterfly valve, ANSI 125/150 pound nodular or cast iron wafer body, extended neck, bronze or aluminum bronze disc, 316 or 416 stainless steel shaft, TFE-coated stainless steel bearings for support of upper and lower disk throat and actuator thrust, O-ring shaft seals at each bearing, 316 stainless steel shaft screws with buna-N O-rings or 316 stainless steel tangential pinning, stainless steel through stem, reinforced nbr seat with integral primary stem seals. Standard applications shall use lever operators for valve sizes 6" and smaller, gear operator for larger sizes. Critical applications shall use pneumatic cylinder actuators with spring return capable of opening or closing valves against 50 psi differential, FV-B shall be spring-to-close, FV-C shall be spring-to-open.

Valves may be oriented with the shaft in the vertical or horizontal plane. When mounted in the vertical plane, the actuator assembly must not be located at the bottom of the pipe. The position indicator must be visible from the ME room floor. There must be sufficient clearance to remove the actuator assembly from the valve. Specify actuator mounting

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position with valve order. Bench-check valve action and travel limits **before** installation. Do not use slip-on flanges next to control valves.

Manufacturer type: DeZurik BRS,(valve size inches),L1,CI,NBR,NBR,BZ,S4*(actuator code) or approved equal

The following additional instruments and functions shall be provided for metering applications:

FE/FT 1Flow Element/DP Transmitter

V-cone type flow element: This flow element and transmitter assembly will be provided by UNC. The Chilled Water Department will purchase this equipment with project funds. The mechanical contractor shall install this flow element in the piping system as specified by the designer. The contractor shall furnish and install flanges for flow meter. Designer shall clearly show the orientation and mounting of the flow element on the construction drawings. In no case should the angular position of the flow element and transmitter allow entrained air to become trapped.

CHILLED WATER BRIDGE PIPING

GENERAL

A specification of an item in this or any other sections shall not relieve Contractor from providing all items, articles, materials, operations, methods, labor, equipment and incidentals necessary for a complete and functional system.

Where size for a pipe segment is not indicated, the pipe segment size shall be equal to the largest pipe segment to which it is connected. Transition to smaller size shall occur on the side of fitting where smaller size is indicated.

All pipe, valves, fittings and pumps shall be installed as indicated on the drawings and according to the manufacturers instructions and installation drawings.

General Locations and Arrangements Drawings (plans, details, schematics, and diagrams) indicate the general location and arrangement of the piping systems. Location and arrangement of piping layout shall take into consideration pipe sizing and friction loss, pump sizing, maintenance accessibility and other design considerations. So far as possible, install piping as indicated.

PIPE MATERIALS

Use only new material, free from defects, rust, scale, and guarantee for services intended.

All Chilled Water piping lines shall be standard weight, Schedule 40 black steel. Chilled Water pipes larger than 2" shall have welded joints and fittings that shall be standard weight Schedule 40 black steel.

Threaded nipples shall be Schedule 80 black steel. Threaded fittings shall be forged steel.

Use only long radius elbows having a centerline radius of 1.5 diameters unless otherwise indicated.

Unless otherwise indicated, fittings and accessories connected to the pipe shall be of the same material as the pipe.

FLANGES

ASTM A105, ANSI B16.5, hot forged steel, welding neck pattern are to be used whenever possible. Bore dimension of welding neck flange shall match inside diameter of connected pipe. Valves may be used to facilitate the fit-up of their flanges, but they must be removed or protected (with a sheet metal pancake or similar device between the flange and valve) before the flanges are welded.

Where slip-on flanges must be used because of space restrictions, the insides of the flanges must be welded. Valves may be used to facilitate the fit-up (tacking) of slip-on flanges, but **they must be removed** before

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the slip-on flanges are welded.

Use raised face flanges for mating with other raised face flanges with self centering flat ring gaskets. Use flat face flanges for mating with other flat face flanges with full face gaskets.

Clean flange surfaces and align flange surfaces parallel. Bolt holes of gaskets shall be cut slightly larger than bolt diameter and gasket ID shall be slightly larger than flange ID.

Lubricate bolts with antiseize compound and run nuts down by hand. Tighten bolts in a crisscross pattern.

FLANGE GASKETS:

Asbestos free fiber type; **apply an antiseize compound to the gasket or flanges.**

Position gasket concentrically so compression is equally distributed over entire gasket surface.

BOLTING:

Bolts and nut shall be Grade 5 NC.

Bolts, bolt studs, nuts and washers shall have zinc plated finish.

Threaded rods are not allowed as fastening elements.

VALVES

For Control Valves see *Chilled Water Instrument Specifications*.

For the Chilled Water Bridge System, other than Control Valves, provide industrial quality butterfly valves, ANSI 150 pound nodular or cast iron wafer body, extended neck, bronze or aluminum bronze disc, 316 or 416 stainless steel shaft, 3 bronze or TFE-coated stainless steel bearings for support of upper and lower disk throat and actuator thrust, O-ring shaft seals at each bearing, 316 stainless steel shaft screws with buna-N O-rings or 316 stainless steel tangential pinning, stainless steel through stem, reinforced edpm seat with integral primary stem seals.

Valves shall be full lug type permitting removal of down stream piping while using valve for system shut-off. Dead end pressure rating to be minimum 275 psi with no downstream flange/piping attached.

Standard applications shall use lever operators for valve sizes 6" and smaller, gear operator for larger sizes.

Manufacturers: DeZurik, Milwaukee, Jamesbury.

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BALL VALVES:

Ball valves for use in chilled water system to be rated for 250 psig at 100°F.

Provide valve neck extensions with sufficient length to allow for insulation.

DRAIN/VENT VALVES

Ball valve as specified above with hose thread adapter and cap. Provide 3/4D minimum drain valve size.

Provide drain valves at all low points and vents at high points of piping systems (even if not shown on drawings) for complete drainage of systems between isolation valves and elsewhere as noted on flow diagram, plans and details.

Whenever possible the drain lines shall be run to the sanitary sewer system.

CHAIN WHEEL OPERATORS

Provide chain operators for manually operated valves 6" and larger, located more than 8 ft. above equipment room floor.

Cast iron or ductile iron adjustable sprocket rims and chain guides. Use galvanized or brass chain and chain closure links to form continuous loop of chain at each operator.

INSTALLATION

Install valves as shown on plans, details and according to valve manufacturer's installation recommendations.

After piping systems have been pressure tested and put into service, but before final adjusting and balancing, inspect valves for leaks. Adjust, replace packing or replace valves to stop leaks.

SHUT-OFF VALVES

Provide shut-off valves where shown on flow diagrams, plans or details.

INSTRUMENTATION

Provide pressure gauges where the CHW lines enter the MER upstream of the supply isolation valve, downstream of the return isolation valve and across the inlet and outlet of pumps as shown in Chilled Water's Design Guidelines Flow Diagram. Provide additional gauges across triple-duty valves, strainers or other equipment that could cause a restriction.

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Pressure gauges shall have a working pressure near the middle of the dial. Gauges shall be Weksler, or equal. Install gauges with a 1/2" or 3/4" thread-o-let, bushing, 1/4" nipple and 1/4" ball valve.

PRODUCT DELIVERY, STORAGE AND HANDLING

Before shipping, all carbon steel piping shall be free of rust and scale, and furnished with plastic end caps/plugs on each end of pipe. Protect flanges, fittings, and specialties from moisture and dirt by inside storage and enclosure, or by packing with durable waterproof wrapping.

Store and handle all materials in accordance with Manufacturer's recommendations to prevent their deterioration and damage. Store all materials in the original containers or bundles with labels informing about manufacturer, product name, and any potential damage.

Where possible, store all materials inside and protect from weather. Where necessary to store outside, elevate well above grade and enclose with durable, waterproof wrapping. When stored inside, do not exceed the structural capacity of the floor.

PIPING INSTALLATION

Remove scale, slag, dirt, and debris from both inside and outside of piping and fittings before assembly.

Install valves, control valves and piping specialties, including items furnished by others, as specified and/or detailed. Refer to drawings and/or manufacturer's recommendations.

Make connections to all equipment installed by others where that equipment requires piping services.

Where interferences develop in field, offset or reroute piping as required to clear such interferences. In all cases, consult drawings for exact location of pipe spaces, ceiling heights, door and window openings or other architectural details before installing piping.

Use fittings for all changes in direction and all branch connections. Weld-o-lets may be used in lieu of fittings for branch take-offs from mains 2" or larger provided that the branch take-offs is two or more sizes smaller than the main. No "stub-ins" will be permitted.

Thread -o-lets must be used at vents, drains, thermowells, etc. Half couplings are not permitted.

Materials of "Weldolets" and "Threadolets" shall match material of piping.

Mitered ells, welded branch connections, notched tees and "orange peel" reducers are not allowed.

Reducers in horizontal piping shall be the eccentric type with the top level.

Reducers in vertical piping shall be concentric.

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Install piping to allow adequate service space for equipment.

Install flanges on apparatus and equipment.

Install vertical piping plumb.

Install piping free of sags or bends. See spacing chart below. Provide ample space between piping to permit proper insulation applications.

Install piping at right angles or parallel to building walls. Diagonal runs are not permitted, unless expressly indicated on the Drawings.

Install piping tight to slabs, beams, joists, columns, walls, and other permanent elements of the building. Provide space to permit insulation applications, with 1" clearance outside the insulation.

Locate groups of pipes parallel to each other, spaced to permit applying full insulation and servicing of valves.

Install piping parallel to building walls and ceilings and at such heights not to obstruct any portion of window, doorway, stairway, or passageway.

Unless specifically indicated, reducing flanges and reducing bushings are not allowed. Reducing bushings may be used for air vents and instrumentation connections.

Install drains throughout systems to permit complete drainage of entire system. This includes but is not limited to all low points, bases of all risers, and at each branch take-off.

Do not install piping over electrical panelboards, switchgear, switchboards or motor control centers.

WELDED PIPE JOINTS

Inspect pipe and pipe fittings for roundness before they are fit-up or set in place.

Properly clean fittings; clean and bevel plain ends of steel pipe before fit-up. Verify joint land and bevel.

Preheat pipe base material as required. Temperature of pipe material must be a minimum of 60°F before welding.

Properly align and adjust joint to acquire a 1/8" gap, plus or minus 1/32", to allow full penetration weld. Verify tolerances after tacking sequence.

PIPE WELDING

All welding shall be performed by a certified welder who is regularly engaged in welding of piping systems.

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All welders' certifications must be on file with the contractor and available to Owner upon request. Owner's representative will perform any observations deemed necessary before, during, or after fabrication to assure, to Owner's satisfaction, that proper welding is provided. Owner reserves the right to perform independent testing of welds. If test results of such examination are unsatisfactory, Owner reserves the right to stop in progress welding work, without any cost to Owner, until resolution satisfactory to Owner is reached.

Unless otherwise indicated, welding shall be done 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

Backing rings (chill rings) or consumable inserts are not allowed, unless specifically requested by Owner or Engineer.

Ground clamp must be placed as close as possible to work so as not to damage electronic equipment in this system or elsewhere in the mechanical room.

Repair any welds not meeting the acceptance criteria at no cost to the Owner.

MECHANICAL INSULATION

DELIVERY, STORAGE AND HANDLING

All insulation material shall be delivered to project site in original, unbroken factory packaging labeled with product designation and thickness. Shipment of materials from manufacturer to installation location shall be in weathertight transportation. Insulation materials delivered to jobsite shall be stored so as to protect materials from moisture and weather during storage and installation. Insulation material shall be protected from long exposure to UV light from sun.

APPLICATION

Minimum thickness is as follows or as per code, whichever is greater. This is not intended to supersede the designer's judgment.

- Fiberglass: 2" thick for all pipe sizes.
- Cellular Glass: 1-1/2" thick for pipe sizes up to and including 4", 2" thick for pipe sizes over 4".
- Flexible Unicellular: 1" thick for pipe sizes up to 1-1/2" (largest size permitted).

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INSTALLATION

Do not insulate any section of system, which must be pressure tested until after it has been successfully tested. Any removal and reinstallation to correct system defects, prior to end of guarantee period shall be accomplished at no expense to Owner.

All insulation installation methods shall be performed in accordance with the latest edition of National Commercial and Industrial Insulation Standards published by MICA (Midwest Insulation Contractors Association) and manufacturer's installation instructions, except as modified in this Section of specifications.

Install all products with good workmanship, with smooth and even surfaces.

Use full-length factory furnished material where possible. Do not use scrap piecing.

Apply insulation only on clean, dry surfaces, after all rust and scale have been removed and testing of systems has been completed.

Install insulating materials with necessary joints and terminations, to permit easy access and removal of equipment sections where inspection, service or repair is required.

Provide beveled terminations at nameplates and uninsulated fittings.

Make longitudinal joints in jackets, where possible, facing toward wall or ceiling.

Apply insulation to each pipe individually. Common insulation applied for adjacent pipes will not be accepted.

Unless otherwise indicated, pipe insulation shall be continuous through non-rated walls and floors.

Where multiple layers of insulation are used, stagger and secure each layer with metal bands.

Apply insulation to pipe, unions, flanges, and fittings, valves and piping specialties with butt joints and longitudinal seams closed tightly.

Laps on factory applied jackets shall be 2" minimum width firmly cemented with lap adhesive, or be pressure sealing type lap.

Joints shall be covered with factory furnished tape (3" minimum width) to match jacket, firmly cemented with lap adhesive.

Secure insulation, except those with vinyl jackets, additionally with staples.

Where staples are used, they shall be on 6" maximum centers, and when used for system requiring vapor

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barrier, lap and staples shall be covered with finish coat of lagging adhesive.

Built-up insulation for fittings and valves shall be made with sectional insulation, wrapped firmly to thickness of adjoining pipe insulation, and bound with jute twine, or built up with insulating cement, and finished to smooth hard surface, and covered with minimum of 9 oz per sq yd rewettable glass cloth.

On valves and fittings requiring vapor barrier, apply 2 coats of vapor barrier mastic with glass fiber reinforcing fabric, after application of insulating cement.

Where terminations of pipe insulation are required, insulation shall have tapered ends, built up and finished as specified for fittings.

Insulate all valves, flanges and elbows, tees and other fittings in insulated piping with the same type and thickness of insulation on adjoining pipe.

For pipes 1-1/2" and smaller, specified pipe insulation and jacket shall be continuous through hanger or support locations and insulation protection shields shall be provided to protect insulation from compressing.

For pipes 2" and larger, where manufactured pre-insulated pipe supports are used at hanger or support locations, extend insulation to insulated pipe supports. To ensure vapor barrier, the contractor shall be responsible for continuity of vapor barrier at insulated pipe supports. Use 3" wide vapor barrier tape at pipe supports.

For contractor fabricated anchors, secure insulation directly to pipe surface and extend up anchor for distance of 4 times insulation thickness. For pre-insulated anchors, cover entire surface of anchors with Type A insulation. Take special care to assure vapor seal at anchor.

PIPE HANGERS, SUPPORTS

HANGER RODS (Metallic)

Rods shall have electro-plated zinc or hot dip galvanized finish.

BOLTS, NUTS, STUDS AND WASHERS

Bolts, nuts, studs and washers shall have electro-plated zinc or hot dip galvanized finish.

INSTALLATION

Support all piping from building structural members using beam clamps, ceiling plates, wall brackets, or floor stands. At no time shall hangers and supports overload building structural members. Fasten ceiling plates and wall brackets securely to structure and test to demonstrate adequacy of fastening.

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1. Coordinate hanger and support installation to properly group piping of all trades.
2. Suspend hangers by means of hanger rods. Perforated band iron or flat wire (strap iron) are not allowed.
3. Piping shall not be supported by other piping, ductwork, or conduit.
4. Pipe hangers or supports are not allowed to penetrate vapor barrier of pipe insulation.
5. Install adequate supports during erection of piping so as not to over stress either piping or equipment to which piping is connected.

HANGER AND SUPPORT SPACING

Space pipe hangers and supports for steel pipe in accordance with the following schedule, with exceptions as indicated herein:

Pipe Size	Max Spacing
Up thru 1-1/4"	7'-0"
1-1/2"	9'-0"
2"	10'-0"
2-1/2"	11'-0"
3"	12'-0"
4"	14'-0"
6"	17'-0"
8"	19'-0"
10" and over	20'-0"

Spacing less than indicated above may be required to conform with building structure design and/or loading limitations.

If pipe size changes between support points, maximum spacing shall be based on the smaller pipe size.

Install hangers and supports to bear on outside of insulation.

Place hangers and supports within one foot of either side of each fitting such as elbow and tee and at each valve, strainer, and other piping specialty for piping 4" and above.

PIPING SYSTEM PRESSURE TESTS

Coordinate pressure tests with Engineer and Owner, in writing, at least 7 days in advance of its occurrence and conduct tests in presence of Engineer. Engineer has right to wave requirement for witnessing test. If engineer is not present conduct test in presence of Construction Manager's representative. Representative shall sign report-verifying results. Contractor shall notify engineer of all tests to be performed.

Conduct pressure test prior to flushing and cleaning of piping systems.

Conduct hydrostatic (HYDRO) test with test medium of water unless otherwise indicated.

Conduct pressure tests at 150 psig.

The testing of the system shall be performed by a contractor experienced in pipe testing. The Contractor shall perform all phases of testing including supervision and provide pumps, appropriately scaled and calibrated gauges, instruments, test equipment, temporary piping and personnel required for tests and provide removal of test equipment and draining of pipes after tests have been successfully conducted.

For hydrostatic tests, remove air from piping being tested by means of air vents. If outlets are not available at high points, the Contractor shall make the necessary taps at points of highest elevations before the test is made.

Contractor shall perform preliminary pressure test prior to witnessed record test to verify system will pass record test on first attempt.

Pressure tests may be made of isolated portions of piping systems to facilitate general progress of installation. Any revisions made in piping systems require retesting of affected portions of piping systems.

No pressure drop shall occur during test period. Any pressure drop during test period indicates leakage.

If leaks are found, repair with new materials and repeat test; caulking will not be acceptable.

Measure and record test pressure at high point in system. Where test pressure at high point in system causes excessive pressure at low point in system, due to static head, portions of piping system may be isolated and tested separately to avoid undue pressure. However, every portion of piping system must be tested at the specified minimum test pressure.

Repair system and retest all portions of system when equipment or system fails to meet minimum test requirements.

No systems shall be insulated until it has been successfully tested. Unless otherwise noted, minimum test time shall be 4 hrs plus such additional time as Engineer may require to assure that no air pockets

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are in the line, no broken pipe or defective materials are in the line, and no leaking joints have been made.

Submit results of each test to Engineer within 3 days of test occurrence for Engineer's review.

FLUSHING AND CHEMICAL CLEANING OF BUILDING CHILLED WATER PIPE SYSTEMS

PART 1 – GENERAL

1.0 SUMMARY

- A. The work under this section is subject to requirements of the Contract Documents including the GENERAL CONDITIONS, SUPPLEMENTARY CONDITIONS, and sections under Division I GENERAL REQUIREMENTS.

1.1 SUBMITTALS

- A. Submit shop drawings for the following:
 - a. Chemicals; description of chemicals, its composition and function
 - b. Material Safety Data Sheets (MSDS):
 - i. Submit directly to Owner the MSDS for all chemicals used for pipe cleaning. Include with MSDS written notice of Owner's responsibility to notify its employees of the use of those chemicals.
 - c. Manufacturer's name and model number
 - d. Capacities/ratings
 - e. Materials of construction
 - f. Dimensions and weights
 - g. All other appropriate data

PART 2 – PRODUCTS

2.1 CHEMICAL MANUFACTURERS

- A. Nalco or approved equal.

2.2 PIPING SYSTEM CLEANER

- A. Use cleaning compound similar to Nalco 2567 to remove organic soil, hydrocarbons, flux, pipe mill varnish, pipe compounds, iron oxide, and like deleterious substances, with or without inhibitor, suitable for system metals without deleterious effects. Cleaner shall contain no trisodium phosphate.

2.3 BATCH CHEMICAL FEEDER

- A. Provide by-pass type batch feeder to receive chemicals in liquid or pellet form.
- B. Feeder shall have capacity of 5 gallons and shall be constructed of steel with minimum working pressure of 150 psig. Feeder shall be complete with air vent, drain valve, inlet and outlet globe valves, and unions.
- C. Furnish feeders with screw type cover with replacement gaskets, or valved funnel opening and with interior epoxy coating and exterior prime coat finish.

PART 3 – EXECUTION

3.1 CHILLED WATER ABOVE GRADE PIPE CLEANING

- A. Contractor to flush and clean all new chilled water piping systems after the system has been successfully pressure tested. Chilled Water personnel shall witness the flushing and cleaning procedures. The Contractor shall provide all water for flushing and cleaning. Flushing water and cleaning solutions shall be discharged to the sanitary sewer system.
 - a. Flushing:

Flush all chilled water pipe thoroughly for 15 minutes or longer, as required to remove all dirt and foreign matter from the system. Bypass all pumps and equipment and remove all strainers from strainer bodies. Provide circulation by Contractor supplied portable pumping apparatus. The building chilled water pumps shall not be used. Provide a temporary 1/8" mesh strainer with the portable pumping apparatus to allow for removal of circulating debris during the flushing and cleaning process.
 - b. Cleaning:
 - i. Drain the system.
 - ii. Fill the system with water, vent and add recommended amount of cleaner. The cleaner should be diluted by at least a 3:1 ratio to prevent excessive attack on metal surfaces at the point of application. (Do not allow any chemicals to come in contact with galvanized surfaces.)
 - iii. Circulate system for 24 hours at the flow rate recommended by the chemical manufacturer. The building chilled water pump shall not be used. Isolate or remove the pump from the piping being cleaned. Ensure that the temporary 1/8" mesh strainer is in place before the cleaning begins.
 - iv. Drain the system and remove the temporary mesh strainer and debris.
 - v. Fill system with water, vent and circulate for one hour. Drain system.
 - vi. Remove the temporary piping and pump and install and align the building chilled water pump if required.
 - c. Final Fill:

Chilled Water Personnel will fill the system with water from the University Chilled Water System.

INITIAL SYSTEM FILL AND VENT

Fill and vent systems with proper working fluids.

PIPE IDENTIFICATION

Install pipe identification on each system. Place flow directional arrows at each pipe identification location.

Identify all piping, not less than once every 25 ft, not less than once in each room, at each branch, adjacent to each access door or panel, at each valve and where exposed piping passes through walls and floors.

Identify piping with marker system. Markers shall be "snap-on" or "strap-on" type depending on applicable pipe size.

Pipe identification labels shall be abbreviated as follows:

Piping System	Identification
Chilled Water Supply	CWS
Chilled Water Return	CWR

Markers to comply with ANSI A13.1 for color, length of color field and include flow directional arrows integrated into the marker.

For insulated pipe systems, lettering sizes are as follows:

1. For pipes up to 1 inch, use 1 inch letters.
2. For pipes 1-1/4 inch to 2 inches, use 2 inch letters.
3. For pipes 2-1/2 inches to 6 inches, use 3 inch letters.
4. For pipes above 6 inches, use 4 inch letters.

BUILDING CHILLED WATER PUMP

DESIGN CRITERIA

Pump sizes, capacities, pressures and operating characteristics shall be as scheduled.

Pumps shall have a minimum clearance of 24" on sides and ends of pumps and motors to allow access for service and repair.

Pumps shall have isolation valves to allow removal of pumps for repair.

Pumps shall have bleed valves and gauge ports at accessible locations.

All pumps shall be serviceable without removing the volute from piping connections.

Pumps shall meet or exceed operating efficiencies scheduled.

Furnish pumps complete with premium efficiency motors, impellers, drive assemblies, coupling guard where required and accessories as hereinafter specified.

Where pump is indicated for parallel operation, scheduled conditions are for that pump with two pumps operating; i.e., total system flow rate is twice that scheduled for single pump. When only one of two pumps is operating, operating point of that pump must fall within manufacturers recommended operating range.

Select motor with sufficient horsepower rating for non-overloading operation over entire pump curve.

Furnish each pump and motor with name plate giving manufacturer's name, serial number of pump, capacity in GPM and head in feet at design condition, horsepower, voltage, frequency, speed, and full load current.

Test all pumps hydraulically at 150% of rated pressure, clean and paint before shipment. Manufacturer shall certify all pump ratings.

All pumps shall operate without objectionable noise or vibration with maximum noise level of 85 dBA.

After completion of balancing, provide replacement of impellers or trim impellers to provide specified flow rate at actual pumping head, as installed.

Furnish one set of seals for each new pump to Owner.

Head for pumps submitted for pumping through evaporators and condensers of chillers shall be increased, if necessary, to match the equipment approved for project.

DOUBLE SUCTION SPLIT CASE CENTRIFUGAL PUMPS

Allis Chalmers, Aurora, Peerless, PACO, Worthington, or Ingersoll-Rand.

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Pumps to be base mounted, double suction, flexible coupled, horizontal split case with cast iron casings, bronze fitted with working pressure of 175 psi and operating temperature of 250 degrees F intermittent. Pump design must allow for servicing with out disturbing piping, motor or requiring shaft realignment. Pumps shall be designed and tested to Hydraulic Institute Standards.

Casings shall be cast iron having a minimum tensile strength of 35,000 psi. Bearing housing supports and suction and discharge flanges shall be integrally cast with lower half of casings. Removal of upper half of casings shall be accomplished without disconnecting suction and discharge piping.

Casings to have tapped and plugged openings for vent, drain, and suction and discharge gauge connections.

Impellers to be double suction type made of cast bronze, enclosed double suction type, hydraulically and dynamically balanced, keyed and locked to pump shafts with replaceable bronze shaft sleeves. Impellers to have bronze wearing rings securely locked in place.

Pumps shall have easily removable casing rings designed such that hydraulic pressure seats them against shoulders in pump cases around entire periphery of wearing rings. Wearing rings to be locked in place to prevent rotation.

Rotating elements shall be mounted in heavy-duty regreasable ball bearings and shall be equipped with water slingers on the side next to pump glands.

Pump shafts to be high strength carbon steel, sealed and gasketed from pumped fluid.

Chilled water pumps to be furnished with single inside, unbalanced mechanical seals with carbon rotating faces, ceramic stationary seats, Buna-N elastomer and 316 SS metal hardware, similar to John Crane Type 1 Seal, rated up to 225 degrees F continuous operation. Bearing assemblies to be cast iron with regreasable ball bearings.

Drop-out spacer type couplings with flexible neoprene sleeves to be used to allow for pump servicing.

Pumps shall be supplied with groutable steel base plates with drip pans and drain connections.

INSTALLATION

Install all pumps in strict accordance with manufacturer's instructions to avoid any stress and misalignment.

Set base mounted pumps on concrete bases, or concrete inertia base, level and bolt down prior to grouting. Fill entire base with non-shrinking grout. Use end caps during grouting to prevent overflow when end caps are not integral with base plates. Housekeeping paid to extend to allow for suction diffuser support.

Piping connections to pumps shall not create stress on pump casing. After final connections are completed, the contractor shall remove bolts from flanged connections at pumps. Piping shall remain aligned with pump connections after bolts have been removed. If piping becomes misaligned after bolts have been

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removed, or if bolts cannot be removed by hand, the contractor shall revise piping to align piping with pump connection. **Piping/pump alignment verification shall be completed in the presence of the Chilled Water representative.** If after completion of the strain free verification the piping system must be disassembled at any point in the system, the strain free verification shall be repeated.

Contractor shall hire a certified technician from the selected pump manufacturer to field align flexible coupled pumps after the base has been grouted and the pipe/pump alignment check has been completed. Align pump and motor in all four planes: vertical angular, horizontal angular, vertical parallel and horizontal parallel. Alignment shall be within the recommended value by manufacturer, but not over .02" parallel and .05" angular. Record and submit all results of alignment procedure to Engineer. **A Chilled Water Representative shall verify pump/motor alignment.**

Contractor shall provide two days notice to Chilled Water for alignment verifications.

Where pump connection size and indicated line sizes are not identical provide necessary concentric reducers/increasers for vertical piping at pump connection and eccentric reducers/increasers for horizontal piping at pump connection. Install eccentric reducers/increasers with top of pipe level. All isolation valves and flexible connections are to be full line size.

Provide drain pan constructed of 16-gauge stainless steel, all welded under pump heads and inlet/outlet flanges, including flanges of connection pipe. Drain pan shall be sized to accommodate entire pump head area from flange to flange. Provide silicone sealant between pump feet and drain pan to make pan leak-proof. Provide ½" drain opening in drain pan and extend ½" drain pipe to nearest floor drain.

Provide a single gauge connected to pump suction, pump discharge, and pump discharge after check valve or balancing valve (which ever is furthest downstream). Gauge is to be connected to the system through a manifold system where each branch can be isolated and pressure can be relieved from the gauge. Gauge indicator shall have a maximum reading of 150 psi.

PUMP STARTUP

Verify that piping system has been tested, flushed, clean and filled.

Verify that pipe/pump alignment has been verified by UNC representative.

Verify that pump/motor alignment has been verified by UNC representative.

Prime pump, vent air from casing and verify that rotation is correct. To avoid damage to mechanical seals, never start or run pump in dry condition.

Perform field mechanical balancing, if necessary, to meet specified vibration tolerance.

Underground Chilled Water Distribution Piping

General

Use only new material, free from defects, rust, scale, and guarantee for services intended. Use material meeting the latest revision of the ASTM specifications as listed in this specification. Use only long radius elbows having a centerline radius of 1.5 diameters unless otherwise indicated. Unless otherwise indicated, fittings and accessories connected to the pipe shall be of the same material as the pipe.

Contractor Qualifications

The Engineer must approve the contractor performing the underground chilled water work. Submit contractor qualifications and references for five (5) similar projects performed in the last 5 years. The contractor must also meet the following minimum requirements:

- Performed a minimum of three (3) underground ductile iron pipeline installations for 24” pipe and larger within the last 5 years.
- Has been in the underground pipeline utility business and has been performing this type of work for a minimum of 5 years.
- Is licensed to perform work in the State of North Carolina.

Submittals

Submit shop drawings for all pipe sizes including, but not limited to, the following:

Pipe; ASTM/ANSI/AWWA number, grade if known, class, type, wall thickness, material

Fittings; ASTM/ANSI/AWWA number, grade if known, class, type, wall thickness, material

Flanges; ASTM number, grade, class, type, material

Test Pressure and media

Pipe cleaning method

Restrained joint calculations; submit complete calculations for all underground ductile iron pipe joints indicating the requirements for restrained and push-type joints. Unless submitted, all joints shall be restrained type. Submission of output data from an approved vendor computer selection/calculation program will be required to justify the use of push-type joints in certain locations. This program shall utilize the depth of cover indicated on the profile drawings, the specified test pressure for the system, a 1.5 safety factor and a ANSI/AWWA C150/A21.50 Type 4 laying condition.

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Delivery, Storage and Handling

Furnish all pipe with plastic end-caps/plugs on each end of pipe. Maintain end-caps/plugs through shipping, storage and handling to prevent pipe end damage and eliminate dirt and construction debris from accumulating inside the pipe.

Pipe Materials

The pipe and fittings shall be suitable for a minimum working pressure of 300 psi, ANSI C151/A21.51, with asphalt coating and cement mortar lining ANSI/AWWA C104/A21.4.

Fittings shall be ductile iron mechanical joint type manufactured in accordance with ANSI/AWWA C110/A21-10, rated for 250 psi working pressure. Straight pipe joints and fittings to be a combination of push-type and restrained joint-type. Joints and fittings shall be flexible and shall be designed to provide positive restraint against end-wise separation due to thrust.

Push type joints shall be equal to American Fastite joint or U.S. Pipe Tyton joint, ANSI/AWWA C111/A21.11, tapered bell opening, 5 degrees lateral offset capability. Gasket material shall be SBR with two hardness; 85 durometer hardness for smaller end of gasket and 65 durometer hardness for larger end of gasket.

Restrained type joint fittings shall be equal to EBBA Iron Series 1100 Megalug restraint systems for mechanical joint ductile iron piping, fittings and valves. Gasket material shall be SBR.

Valves

Gate Valves

Conform to latest version of the AWWA Standard C-509 for resilient seated gate valves. There shall be a non-rising stem. The stem shall be cast bronze. The stem stuffing box shall be the O-ring seal type with two rings located above the thrust collar. The valve shall have a smooth full diameter waterway with no recesses.

The valve body and wedge shall be cast iron or ductile iron and shall be coated inside and outside with epoxy. The epoxy coating must meet or exceed AWWA C-550. The valve shall be designed for a pressure rating of 200 psig and shall be hydrostatically tested at 400 psig. The wedge must be completely encapsulated with rubber. Valves shall be furnished with ground level indicators and extension stems.

Manufacturers: U S Pipe, Clow or approved equal.

Butterfly Valves

Conform to latest version of AWWA Standard C504. Valves to be tight closing, rubber seated. Valves to be bubble tight at the rated pressure in either direction and shall be suitable for throttling service and operation after long periods of inactivity. Valves shall be rated for 250 psi non-shock service working

STANDARD SPECIFICATIONS

pressure, minimum. Valves to be designed for direct buried application.

Cast iron body ASTM A-126B, Class B, restrained mechanical joint (AWWA C-151/ANSI 21.11) or flanged (ANSI B16.1) ends. Valve shall be furnished complete with joint accessories (bolts, nuts, gaskets and glands).

Resilient seat shall be natural rubber (Buna-N) bonded or mechanically retained in the valve body. The seat shall be capable of mechanical adjustment in the field and field replacement.

Valve discs shall be constructed of cast iron ASTM A-126, Class B or ductile iron ASTM-A-536. Disc shall have stainless steel seating edge to mate with valve seat.

Valve seat to be 18-8, type 304 stainless steel.

Shaft bearings shall be contained in the integral hubs of the valve body and shall be self lubricated sleeve type and shall be sealed in place with self adjusting packing.

Valves to be hydrostatically and leak tested in accordance with AWWA C-504.

Valve to be complete with grease packed buried service gear operator, shaft extensions, soil pipe and ground level position indicators.

Manufacturers: Pratt, Dezurik, Clow, or approved equal.

Valve Boxes and Position Indicators

Valve boxes shall be 2 – piece cast iron, screw type, 5.25” shaft with stay-put heavy duty traffic weight lid marked “CHILLED WATER”. Boxes shall be equal to figure UTL 273, as manufactured by Charlotte Pipe and Foundry Co., Dewey Brothers or Tyler.

Valve position indicators shall be equal to Henry Pratt Diviner.

Tapping Sleeves

The shell, flange, bolts, nuts, and test plug shall be constructed of 304 stainless steel. The flange shall be drilled with an ANSI 150 pound pattern. The bolts and nuts shall be 5/8” NC thread. The bolts shall be coated with Teflon, and plastic lubricating washers shall be provided. All welds must be fully passivated prior to shipment.

The full circumference shell seal gasket and flange gasket shall be made of virgin SBR. The flange gasket must be glued in place.

The tapping sleeve shall be a Romac Industries Model SST or approved equal.

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Installation

All pipe, valves and fittings shall be installed as indicated on the drawings and according to the manufacturers instructions and installation drawings.

All connections to existing pipe shall be by wet tap. The existing pipe will not be taken out of service to allow a connection.

Provide vents at all high points of pipe sections. Provide drains at all low points of pipe sections. Whenever possible the drain lines shall be run to the storm sewer system. If storm sewer is not available provide a pump out manhole (see Standard Details).

Provide a 24" diameter pre-cast concrete pad around all valve boxes (see Standard Details). Do not locate valve boxes in parking spaces or in other inaccessible locations.

Provide a chilled water monument marker at each change of direction, branch, and 200 feet of straight run of pipe. The marker shall consist of a brass chilled water marker (provided by the University) in the top of a 18" long piece of 6" diameter PVC pipe filled with concrete. The marker shall be located midway between the two chilled water pipes.

CLEANING, FLUSHING AND TESTING OF UNDERGROUND PIPING

Chilled Water (4" to 42"):

Contractor shall visually inspect internal portion of each length of pipe during installation. Remove all dirt and foreign matter prior to installing additional lengths.

After each major section of piping has been installed, it shall be cleaned and flushed utilizing a high-pressure water "hydro-jet" process. The hydro-jet process involves passing a high pressure, high volume spray type cleaning head through the piping. The head is inserted in each section of piping and activated with full water pressure and flow. Through hydraulic force from directional spray nozzles the head propels itself forward up the pipe section. Once the head reaches the end of the pipe section it is retracted while maintaining maximum water pressure and flow. The length of the piping section shall be determined ahead of time so that the proper amount of travel can be tracked with calibrated markings on the spray head feed water hose or a meter on the hose reel. While traveling through the piping the pressurized water spray knocks debris loose and carries it back to the open end of the piping where it is collected and removed from the system. For each section of piping the process shall be performed a minimum of two times and shall be repeated until the water exiting the end of the pipe is clear and free of debris as determined by the Owner/Engineer.

The hydro-jet equipment utilized shall be capable of providing a minimum of 50 GPM at 2000 PSI.

All cleaning and flushing shall be performed so that all debris will be pulled or flushed downhill. All cleaning and flushing shall be initiated from all low points in the system and shall terminate at the nearest adjacent high point in the system.

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Coordinate the limitations and requirements of hydro-jet process with the flushing subcontractor such that the piping is installed in a sequence and manner that allows every section of the new pipeline to be cleaned and flushed. Limitations may include maximum length of the pipe section, maximum number and/or degree of bends in the pipe section, maximum slope of the pipe section, equipment and excavation access requirements, and the minimum size of the openings required in the piping to allow for insertion and retraction of the cleaning head.

Contractor shall provide access at all low points through valves, tees, flanges, etc. to facilitate the cleaning and flushing process. If temporary fittings or piping is required it shall be provided by the Contractor and removed by the Contractor after successful cleaning.

After flushing and cleaning is completed, contractor shall provide necessary pipe and fittings required to complete the piping system. Each cleaned section of piping shall be capped and protected to keep mud, debris, water, etc. from entering the piping. If a piping section is left open or unprotected, or is contaminated, it shall be re-cleaned prior to being filled and activated at no cost to the Owner.

Contractor shall provide all water for flushing and testing. Coordinate rental of fire hydrant meters with local Fire Department(s), or the University as required.

Contractor shall provide all temporary piping from water source to piping system and shall provide means for conducting cleaning water from underground piping system to the appropriate sewer; i.e. pumps, piping, hoses, tanks, etc. Contractor to remove all temporary piping, pumps, hoses, etc. from site immediately after flushing has been completed.

Testing

The chilled water piping shall be leakage rate tested. Leakage rate test shall be conducted at the same time as the hydrostatic pressure test. Leakage rate is defined as the quantity of water that must be supplied into the respective underground piping system to maintain the pressure within 5 psig of the specified hydrostatic test pressure after air in piping system has been removed and piping system has been filled with water.

Determine the maximum allowable amount of leakage by the following formula:

$$L = S * D \text{ SQRT } (P) / 200,000$$

L = allowable leakage in gallons per hour

S = length of pipe tested, in feet

D = nominal diameter of pipe in inches

P = average test pressure during leakage test in pounds per square inch

STANDARD SPECIFICATIONS

The test pressure shall be 180 psig at the highest point of the piping being tested.

The Contractor is required to furnish all pumps, gauges, instruments, test equipment, and personnel required for tests and make provisions for removal of test equipment and draining of pipes after tests have been made. All testing shall be made in the presence of the Engineer.

The pressure tests shall be sustained for not less than two hours and as much longer as the Engineer may require to assure that:

No air pockets are in the line

No broken pipe or defective materials are in the line.

No leaking joints have been made.

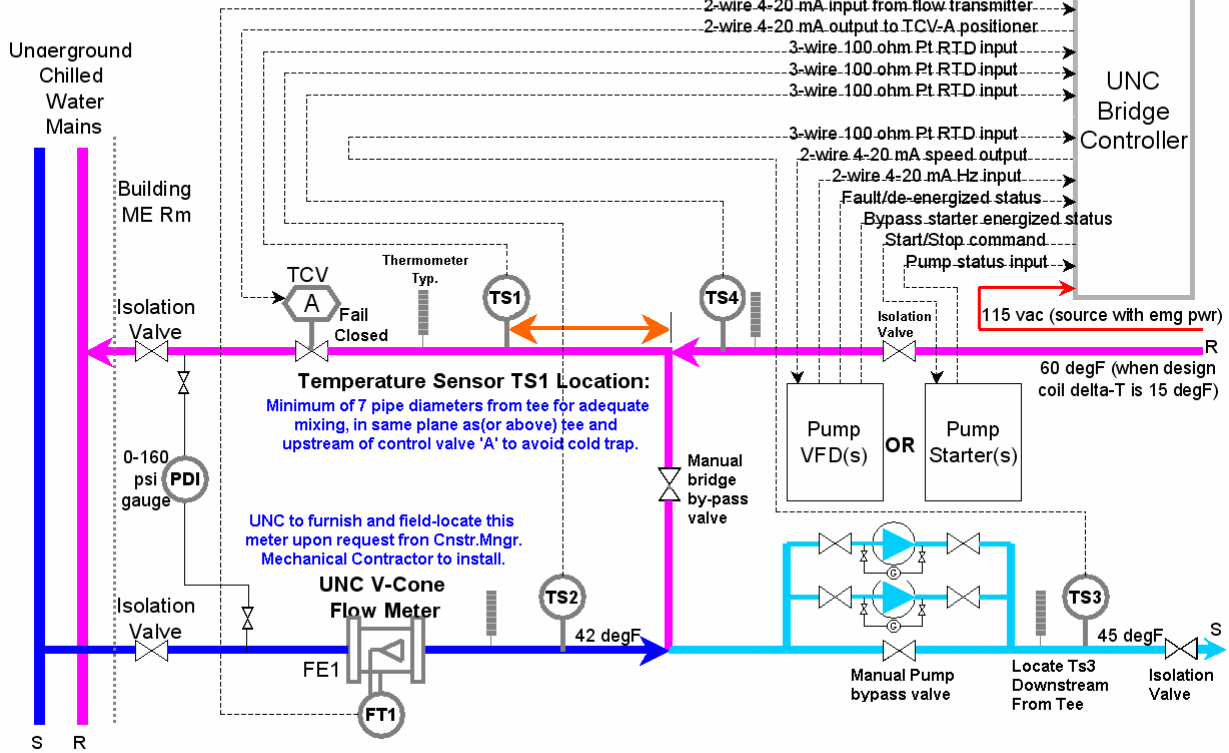
Before applying the specified test pressure, all air shall be expelled from the pipe. If outlets are not available at high places, the Contractor shall make the necessary taps at points of highest elevations before the test is made. After the test is completed, corporation cocks shall be installed at these points and marked by the installation of a valve box.

Tests may be made of isolated portions of such piping as will facilitate general progress of the installation. Any revisions made in the piping systems will subsequently necessitate re-testing of such affected portions of the piping systems.

Any defective material or defects in workmanship that develop during the tests shall be remedied and the subject piping shall be re-tested.

Standard Building CHW Bridge

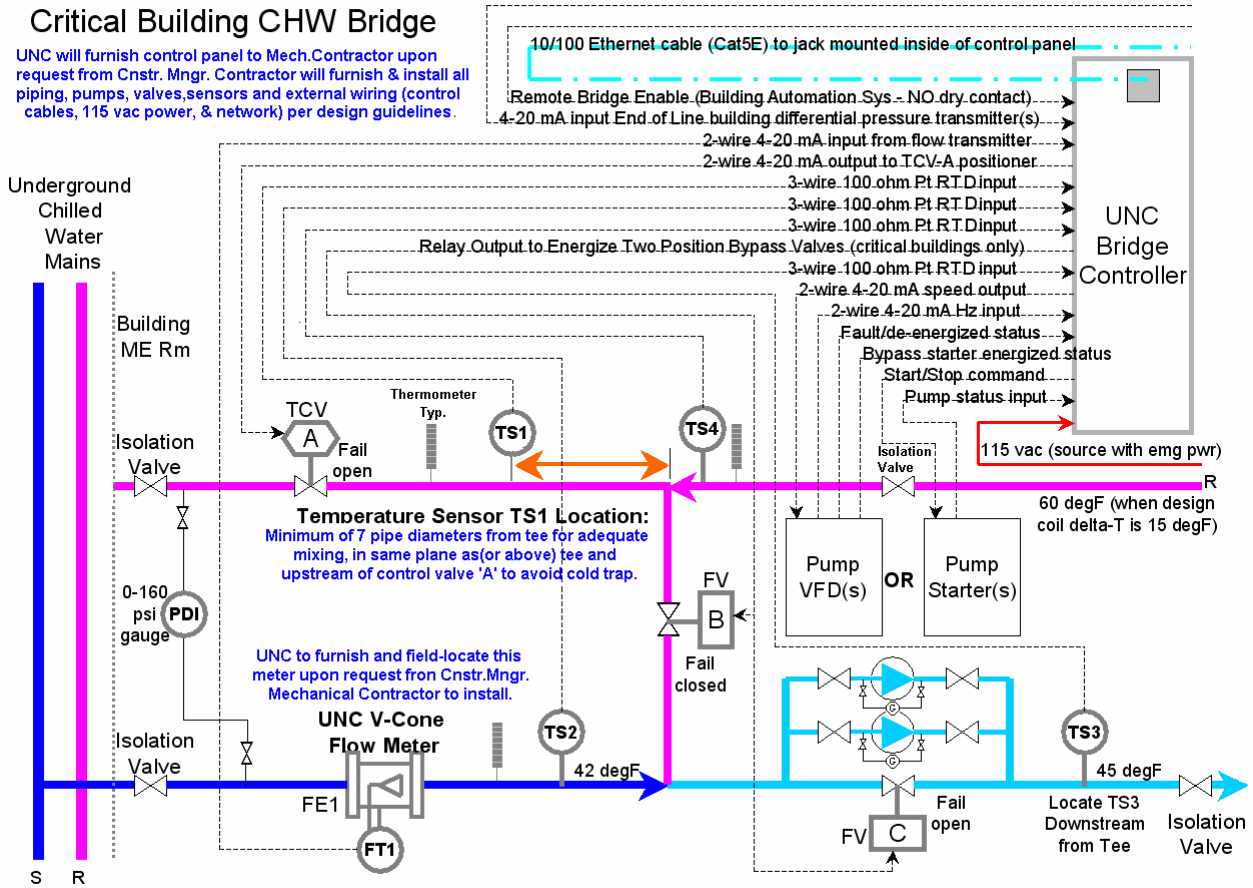
UNC will furnish control panel to Mech. Contractor upon request from Cnstr. Mngr. Contractor will furnish & install all piping, pumps, valves, sensors and external wiring (control cables, 115 vac power, & network) per design guidelines.



STANDARD DETAILS

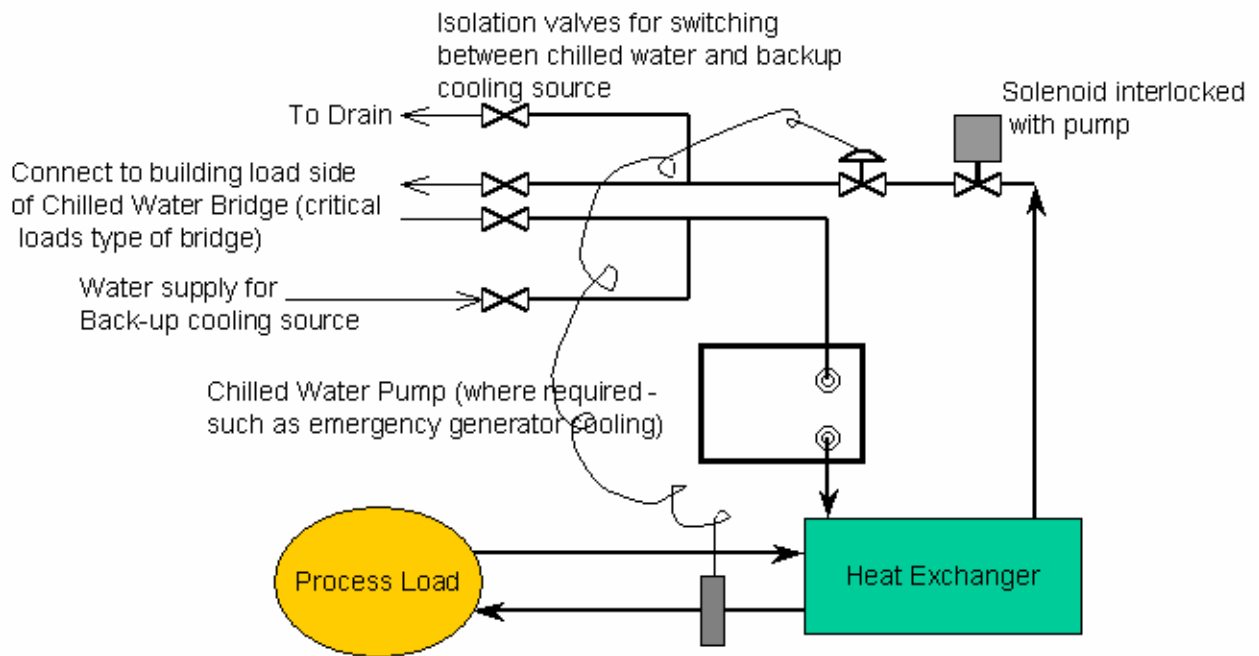
Critical Building CHW Bridge

UNC will furnish control panel to Mech. Contractor upon request from Cnstr. Mngr. Contractor will furnish & install all piping, pumps, valves, sensors and external wiring (control cables, 115 vac power, & network) per design guidelines.

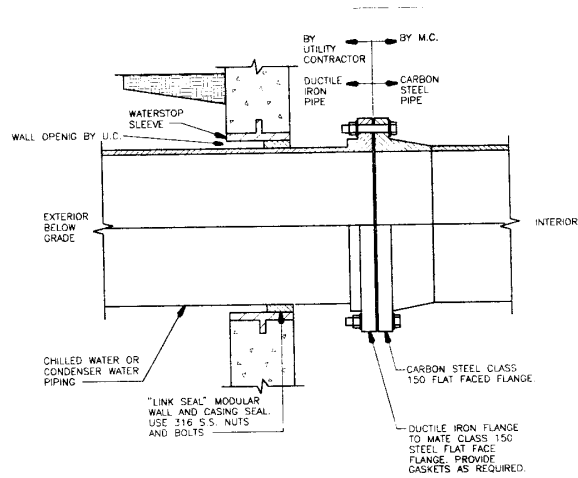


STANDARD DETAILS

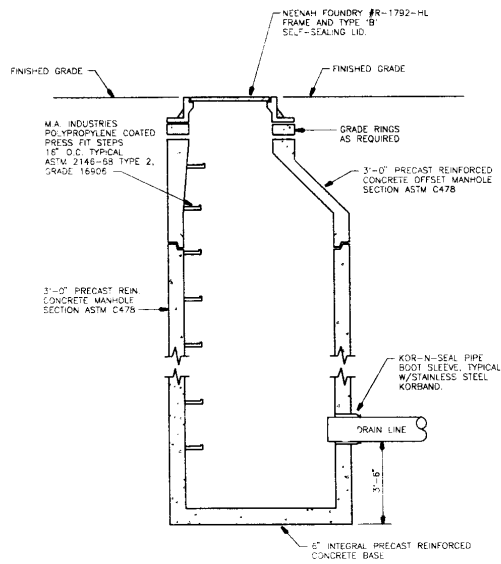
Process Load – Using Self-Actuated Temperature Regulator



Sensing bulb is located in cooling water supply line to process load. Install sensing bulb close to heat exchanger for better control during shutdown. Select valve to close on falling temperature.

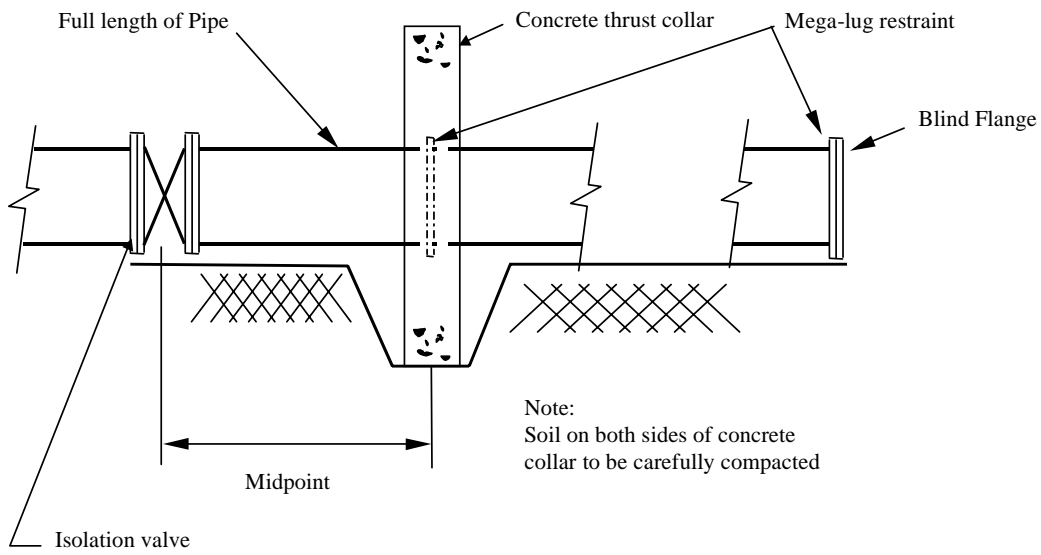


Ductile Iron/Steel Pipe Transition at Wall Penetration

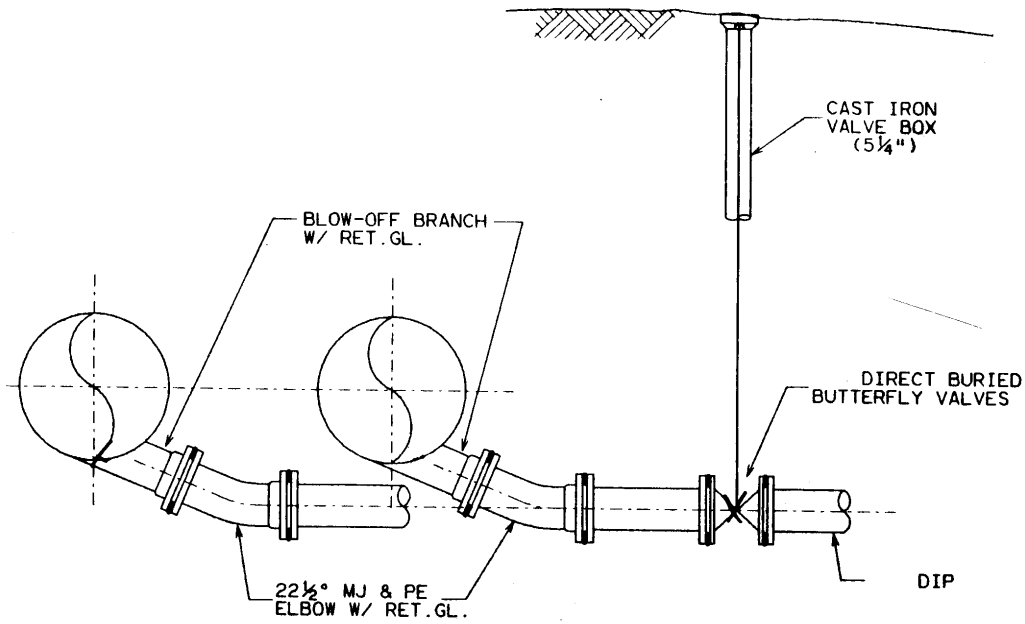


Pump out Manhole Detail

STANDARD DETAILS



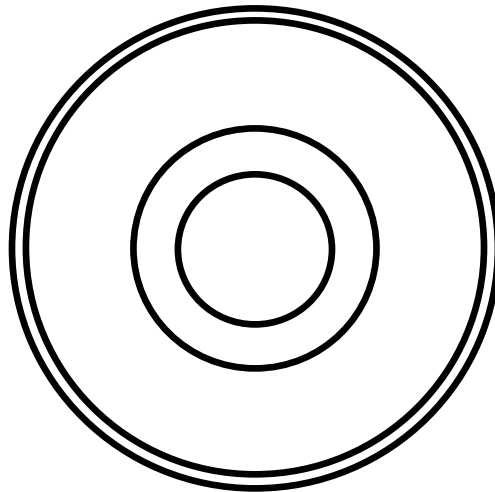
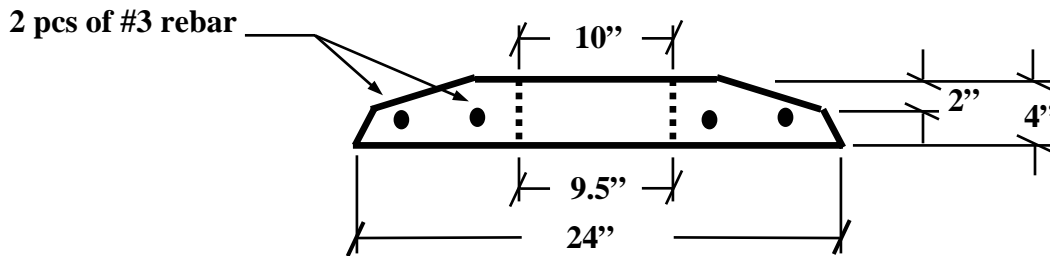
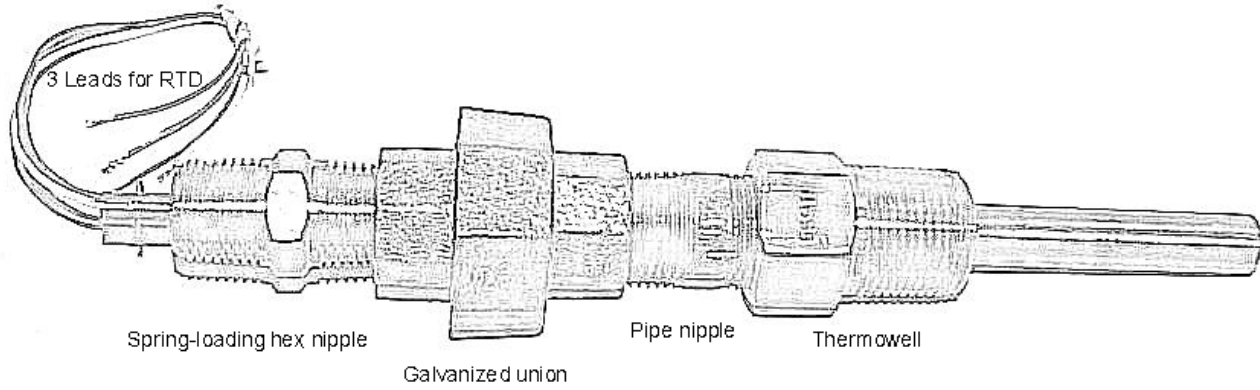
End of Line Detail



Drain Detail

STANDARD DETAILS

Spring-Loaded Temperature Sensor Thermowell Assembly



Pre-cast Concrete Valve Box Pad STANDARD DETAILS