DIVISION 33 – UTILITIES

Includes the following sections:

DESIGN REQUIREMENTS	**33 05 00**

DESIGN DOCUMENTS REQUIRED:

Design Professionals shall perform the following tasks to ascertain, document, and disclose appropriate information for UCSC Engineering Services and UCSC Physical Plant Shops review during design development and construction document development:

1. Prior to starting any planning or preliminary design, request Campus Utilities GIS Map and Sector Maps of existing utilities applicable to the project site. Note these documents are not completely accurate and the accuracy of these documents needs to be confirmed prior to the commencement of any design. Site surveys via an independent utility locator and/or coordination with UCSC Physical Plant Shops will be required to ensure all of the provided information is accurate before any design.

2. Prior to starting any planning or preliminary design, request the current version of the Campus Master Plan for the Utility under project consideration as follows:

a. Project 11409-002A: Sewer Master Plan
b. Project 11409-002B: Cooling Water Master Plan
c. Project 11409-002C: Circulation Master Plan
d. Project 11409-002D: Domestic/FP Water Master Plan
e. Project 11409-002E: Electrical Master Plan
f. Project 11409-002F: Telecommunications Master Plan
g. Project 11409-002G: Natural Gas Master Plan
h. Project 11409-002H: Heating Water Master Plan
i. Project 11409-002I: Integrated Water (Watershed/Non-Potable) Master Plan (Under Development as of 2024)
j. Project 11409-002J: Karst Master Plan
k. Project 11409-002L: Housing Mitigation

3. Studies: Where new utility systems are being added to existing systems, the entire existing system shall be studied for the effect of the newly added loads. This is particularly important for water systems' sizing, water flow capacities, and performance (internal pipe velocities, water pressure losses, etc.). Designers shall confer with University Representatives, such as UCSC Engineering Services and UCSC Physical Plant Electrical/HVAC/Plumbing Shops personnel for known limitations or problems associated with each existing Utility system that is being added. Many older Electrical, district HVAC, and water system equipment, valves, etc. are in poor shape and unsuitable for continued use and may be on a deferred maintenance list for replacement. All of these issues should be discovered and documented during the design phase to ensure the new Utility systems are properly designed and budgeted for before going out to bid.

4. Coordination with UCSC Physical Plant Electrical/HVAC/Plumbing Shops: The campus service technicians have a lot of direct experience maintaining existing utility systems on campus relative to any new project. They have design and equipment specification preferences that change regularly based on learned challenges encountered on previous projects, thus they should be engaged early in the design development process to take advantage of lessons learned to identify any shortcomings of designs and specifications of equipment they specifically do/don't want to have to maintain, or is in dire need of replacement that might present a material risk to the new project.

5. Coordination with Facilities Engineers: Civil Engineer shall coordinate with Facilities MEP/FP/BMS Engineers for any new building's utility system's demand requirements such as, but not necessarily limited to, domestic/irrigation/non-potable/fire protection water services for maximum probable water flow (GPM) and pressure (PSIG) and maximum water fixture units (WFU), maximum sanitary sewer fixture units (DFU), maximum natural gas flow (CFH), electrical load (Kw/voltage/amps/phase) and generator power (emergency and/or standby) requirements, and include this information in the single line diagrams. The purpose of this requirement is to ensure this coordination has been performed and documented as the basis of design for Engineering Services to adequately check it.

6. Single Line Diagrams Required:
    a. Water Meter Assemblies. Includes domestic, non-potable, and irrigation.
    b. Gas Meter Assemblies. Includes Facilities and Generators.Shop
    c. Electrical Metering and Services. Includes Facilities.
    d. Power Generators: Natural Gas and Propane piping diagrams from source to generator. The Civil Engineer shall coordinate with the Facilities Electrical Engineer for generator specifications for an internal vaporizer if the propane tank size cannot adequately provide the fuel phase change from liquid to vapor above the generator's maximum vapor fuel demand. External vaporizers are prohibited. The Civil Engineer shall coordinate with the Facilities Plumbing Engineer and/or the Facilities Data/Comm Engineer to disclose the

need for integration of the natural gas metering to the BMS/campus Ethernet connection requirements.

7. Campus Design Guide Details: All details disclosed by the University are intended to be fairly generic depicting minimum design requirements of components, configuration, functionality, coordination between trades, etc., and are provided to assist the Civil Engineer in designing, developing, and disclose their own details within the construction documents. The Campus Design Guide Details shall not be cut and pasted into design or construction documents as they do not present a fully vetted design. This is left to the Civil Engineer to provide.

8. Division 22 versus Division 33: Within five feet of the building footprint, Division 22 applies. Greater than five feet from the building footprint, Division 33 applies. Close coordination between Division 22 and Division 33 is required. Coordination with UCSC Engineering Services and UCSC Physical Plant is required.
   a. At about 12 inches above finished floor, risers can transition to the pipe materials specified for Facilities piping.

UTILITY PLANNING

1. The University has conducted master plans of the campus utility systems previously listed above. Consult with the University's Representative for the most current versions, if any addenda to such exists, and any other project-specific requirements.

2. Refer to Division 27 for Outside Plant Telecommunications Infrastructure Planning guidelines and coordinate with other utilities specified herein.

3. Utility Corridors: All utilities greater than two inches. diameter shall be installed in utility corridors. A corridor is defined as an easement dedicated to the utilities installed. The purpose of the easement is to enable access for maintenance and service of the utility and to preclude constructing features on top of the utility, thereby blocking access. Where applicable, all Utility Infrastructure shall be generally oriented to align with roadways or other corridors so as to not create conflicts or impediments to future construction. Corridors shall be planned to allow for adequate space for maintenance and future lateral connections from individual projects.

   a. The utility corridor shall be a minimum of 10 feet wide and be accessible by a backhoe.
   b. Utility mains serving two or more buildings shall be located a minimum of 20 feet from any structures. If a 20-foot clearance cannot be achieved, consult the University's Representative.
   c. Branches serving a single building shall be located a minimum of 10 feet from any adjacent structure. If a 10-foot clearance cannot be achieved, consult the University's Representative.

4. Utility lines shall be aligned to remain outside of the future drip line of all existing and planned trees.

5. Utility lines shall maintain a minimum of three feet of horizontal separation from other existing or planned utilities.

6. Prepare profiles and trench sections and coordinate with other site utilities such as water, sewer, storm and sanitary sewage, and IT systems, and verify services with the University Representatives.

7. For sites with multiple underground utilities, a fully coordinated design shall be developed during the CD phase. All utilities (i.e. civil, electrical, telecom, and gas) shall be plotted on a common

set of drawings both horizontally and vertically. Adequate spacing shall be verified in all directions. A typical cross-section shall be included in the CD package for each major utility corridor. In the case of space conflicts, precedence shall be given to gravity flow utilities. All utility crossing points shall be detailed in the CD package.

8. Stacked utilities in a common trench shall not be allowed without special permission from the University's Representative. The services of a joint trench consultant is recommended for such conditions.

POTHOLING

To the maximum extent practical, potholing shall occur during the design phase and before finalizing the construction documents; otherwise, this should be one of the first tasks undertaken during construction. Pothole all existing utilities that need to be exposed during construction including; utility crossings, and points of connection. Potholing shall be done using non-destructive methods and shall be included in the construction contract.

INTERFACE TO BUILDINGS

The main campus is in a rural setting with the potential for significant grade changes. Utility Designers need to coordinate with Building Designers on the interface between the site and building utilities and provide notes and details to ensure upstream ducts are sealed and penetrations into buildings and equipment are provided with rodent prevention measures such as maximum one-quarter inch, stainless steel wire mesh with foamed sealants at service entrances and adequate consideration for drainage of conduits is provided.

UTILITY SHUTDOWNS

The need for a shutdown of existing utilities impacting other campus entities should be anticipated as part of the design. Inform the University's Representative of existing utility shutdowns required to implement a design no later than the 50% Design Development phase. In some cases, a utility shutdown may prove unacceptable for the overall campus. In such cases, the University's Representative may request that a plan be developed to minimize the shutdown impacts with provisions called out on the construction documents. Contractor shall submit a detailed Method of Procedure (MOP) for each utility that requires a service interruption including the following information:

- Lock out Tag out procedures
- Standard operating procedures
- What systems are to be secured and by whom
- How systems will be secured and by whom
- Why will the systems be isolated or shut down
- What methods and materials will be used to tie into existing systems
- Who are the contact persons on the job site in case something goes wrong
- Action plan in the event something goes wrong ie; back up materials on site
- How long is the duration of the shut down
- Confirm when the shutdown will occur
- Establish the communication chain from University Representative to UCSC Physical Plant when exactly to secure UCSC Physical Plant Shops personnel to de-energize and/or reestablish systems when contractors desire to have it scheduled and are ready. University Representatives

shall be available to relay information between contractors and the Physical Plant.

A draft listing and schedule of systems to be shut down is to be submitted to the University Representative not later than 14 days after issuance of the Notice to Proceed. At least 90 days of preliminary written notice shall be given prior to any utility interruption. Contractor shall contact the University Representative to schedule a pre-shutdown coordination meeting with the UCSC Physical Plant with seven days advance notification of the meeting. The MOP shall be submitted, reviewed, and approved 30 days prior to the desired date for service interruption. Final written notice, on University supplied form, shall be given a minimum of seven working days in advance of utility interruption. Any interruption of utility service will be made by The University upon such notice. The Contractor shall not interrupt any utility service.

UNDERGROUNDING

Except for utility devices covered below, all exterior utilities on the UCSC campus shall be underground. Under special conditions, an exception to this requirement may be allowed with the approval of the University's Representative.

UTILITY DEVICES

Utility Devices include any device or equipment that forms part of the Utility System, such as backflow preventers, transformers, fire hydrants, meters, pressure-reducing stations, and other utility devices ("Utility Devices").

1. The locations of above-grade Utility Devices shall be integrated into the building and landscape design concept. Locations shall be coordinated between the Engineers designing the utility and the Landscape Architect, Building Architect, and the University Representative as applicable. A site shall be chosen that allows for full functionality and also integrates well with the overall area design concept. Above-grade Utility Devices shall not be allowed near the main entrances to a Building. The design location of the above-grade Utility Devices shall be indicated on the Design Development site plans. Limited vehicle access is unacceptable for Utility Devices that may require vehicles for maintenance; for example, manholes.

2. Visible Utility Devices shall be designed as integral elements of the overall design and housed within the building footprint or visually screened by architectural or landscape screening (e.g. within service yards) to minimize visual impacts or circulation conflicts for Users. Screening or location shall not impair the Utility Device's function, access, or maintainability. Screening shall not be used for fire protection devices requiring high visibility.

3. Above-grade Utility Devices shall be set on concrete pads sized to provide a minimum of three feet of hard working surface at any required access points.

4. A minimum setback of three feet is required for all Utility Devices and fire department connections located behind a curb so as to avoid vehicle impact. In the event that such Utility Devices or fire department connections are exposed to damage or vehicle impact, protection for such elements shall be provided per the California Fire Code and where the University requires them.

5. Vaults shall not be located on primary walking paths and shall be shown on design development site plans. If a drain is installed in vaults, discharged water shall drain to the landscape. Discharged water shall not enter a piped storm drain.

6. All above-grade Utility Devices shall be painted or coated to protect them from corrosion and to

minimize their visual presence. Utility Devices shall be of a uniform color and finish. Specific paint or coating shall be subject to the University's review and shall be consistent with current University practices.

7. Water valve boxes, gas valve boxes, sewer cleanout boxes, or sewer manholes shall not be installed in the following areas:

    a. Parking stall
    b. Gutter
    c. Drainage swale or ditch
    d. Bus pullout
    e. Within five feet of any permanent structure or overhang
    f. Narrow pathways

8. Do not install sewer manholes, grease interceptors, or lift stations within 25 feet of any building air intake.

UTILITY LINE SIGNS, MARKERS, AND FLAGS 33 05 26

BURIED UTILITIES

1. All buried utilities shall have either a sand or slurry backfill distinguishable from the surrounding native soil. The purpose of this material is to alert trenching equipment operators that trenching is occurring in the vicinity of an existing buried utility. Refer to Campus Design Guide Standard Utility Trench Detail and the requirements of PG&E Greenbook latest edition.

2. All nonmetallic pipe shall be laid in the trench with a #10 AWG shielded copper wire attached to the side of the pipe at intervals and extended to valve boxes or other locations suitable for attaching pipe locating instruments.

3. Underground detectable warning tape shall be installed above all buried utilities approximately 12 inches below finished grade. The tape shall state the name of the utility buried below and be in an industry-standard color associated with that utility. For concrete-encased duct banks, provide one warning tape for each 12 inches width of the concrete duct bank or a fraction thereof.

4. Provide flexible utility marking posts at buried utility crossings of roads, paths, fields, gardens, and other locations where digging is likely to occur. The posts shall be made of fiberglass-reinforced composite material, 4" wide x 60" long x .375" thick. The posts shall be color-coded per industry standards for the utility being protected and clearly labeled with the name of the utility. Coordinate with the overall landscape plan. In locations where landscape aesthetic appeal is of high importance, determine acceptable alternate means for indicating utility crossings.

UTILITY METERS 33 05 33

GLOSSARY

ACFH - Actual cubic foot per hour.

AMI - Advanced Metering Infrastructure.

AMR - Automatic Meter Reading.

BACnet - ASHRAE Communications Protocol for Building Automation and control networks.
Beacon AMA - Badger Meter Advanced Metering Analytics platform for water meters.
BMS - Building Management System (Building Automation System).
CCF - Hundred cubic feet.
eGauge - Electric meter and data logger with web interface.
EIS - Energy Information System.
Ethermeter - Revenue-Grade Flow Meter Gateway For SCADA.
GPM - Gallons per minute
Modbus - Modbus is a serial communications protocol originally published by Modicon.
Niagara - Building Automation framework built by Tridium.
ORION Endpoint - Communicates meter reading data via the LTE-M cellular network.
PF - Power factor.
PME - Power Monitoring Expert developed by Schneider Electric.
SCADA - Supervisory Control and Data Acquisition.
SCFH - Standard cubic feet per hour.
SkySpark - A building analytics system which will be fed data through the Campus Network.
Tridium - Building Automation Software Company.
VAR - Voltage-ampere reactive

BACKGROUND

This Standard is intended to provide metering specifications for campus utilities. Included in this Standard are requirements regarding separation of utility usages, meter sizing criteria, and connectivity standards. If you have any questions about this Standard, please contact the Energy Management department at energy@ucsc.edu.

GENERAL

1. At least one Main Meter per utility type must be provided for each building or structure.
2. The following Main utilities must be metered separately:
   - Electricity (E)
   - Natural Gas (G)
   - Water (W)
   - Irrigation (I)
   - Reclaimed Water (Rain Water, Grey Water, etc.) (RW)
   - Heating Hot Water (BHW)
   - Chilled Water (BCH)
   - Condensing Water (BCD)
   - Sewer Wastewater (WW)

3. Sub-metering shall be provided for buildings that include areas of mixed-use or mixed-funding. Examples of this include but are not limited to:
   - Buildings that contain divided areas with partial state and partial non-state funding.
   - Buildings that house an outside vendor in a portion of the building.
   - Buildings with a portion of utility usages that need to be billed to a separate account than the rest of the building.
   - Buildings with multiple main entry points for a single utility type.

- Buildings that house District-level equipment.

4. Meter Sizing Requirements
   - For all utilities, selected meters must perform within the building's designed minimum and maximum flows.
   - The minimum resolution of any meter must be able to capture the lowest load condition likely to occur in the building.

5. Manufacturers' meter documentation, test results, and calibration reports shall be submitted for all meters.
6. Separate meters must be installed on Emergency and Standby equipment.
7. Meters must be installed to manufacturers' specifications.
8. Meters must have registers that visually display totalized values.

COMMUNICATIONS, DATA, AND MONITORING

1. Contractors must ensure that meters are connected to the Campus Network, most commonly by installing an active campus network jack, validating the connectivity, and assigning a dedicated IP address to each metering device. The campus operates multiple Energy Information Systems (EIS). Coordinate with the University Representative for identification of the specific systems that metering data is to integrate to for a given project. The systems relevant for metering projects include:
   - The campus Building Management System's (BMS) Tridium Niagara platform;
   - The campus SCADA system which is based on the Schneider PME (Power Monitoring Expert) system;
   - Energy Management's SkySpark server, a building analytics system which is connected to through the Campus Network;
   - Energy Management's Beacon AMA water platform.
2. Coordinate with UCSC energy management and the commissioning team to validate connectivity and commissioning, and to connect applicable meters to the corresponding EIS.
   Metering Trend Points are provided in the following table, and represent the minimum metering capability requirements for each utility type.

TABLE 1. Metering Connectivity and Trend Points

UTILITY	MONITORING POINTS	RECORDING INTERVAL	CONNECTIVITY SPECIFICATIONS
Electric	kW, kWh, Volts, Amps, kVAR, kVA, Power Factor (PF), I_{AVG}	5-minute	Main-Metering: ● Connect to SCADA via the Campus Network. Sub-Metering: ● Connect to campus network, and coordinate with ITS to create firewall rule for connection to SkySpark.
Natural Gas	Pressure regulated flow	Per unit	Type A pulse output twisted pair which is then connected to Ethermeter which in turn is connected to the SkySpark server via Campus Network.
Potable Water	Flow, Leak Detection	15-minute	Cellular data connection via Badger Meter ORION Cellular LTE-M Endpoint to campus Beacon AMA.
Irrigation			
Reclaimed Water			
Heating Hot Water (BHW)	Volume flow, supply temperature, return temperature	5-minute	Data connection to campus BMS via BACnet/IP and connection to the Campus Network.
Chilled Water (BCH)			
Condensing Water (BCD)			
Sewer Wastewater (WW)	Volume flow	15-minute	Data connection to campus BMS via BACnet/IP and connection to the Campus Network.

METER SPECIFICATIONS BASED ON UTILITY TYPE AND USAGE:

TABLE 2. Electric Meter Specifications

UTILITY	SERVICE	SERVICE	MANUFACTURER / MODEL
Electric	Main-Metering, Service Level	Main metering of 277/480V and 120/208V 3 Phase services	Schneider PowerLogic PM8000
		Main metering of 120/240V single phase service	Schneider PowerLogic ION8650
	Sub-Metering	Sub-metering of panels, circuits, and/or renewables	eGauge Pro EG4130

Notes:

- All Schneider Electric meters must be integrated into the campus SCADA system and the Campus Network.
- All eGauge meters must be configured with appropriately sized current transformers (CTs), properly commissioned (submit photos and paperwork), and connected to the SkySpark server via the Campus Network.
- eGauge Sub Metering should capture the main load on any panel it is installed on in addition to the prescribed individual circuits.
- Consult with University representative to determine level of granularity for Sub-Metering. Guidance will vary by site but will be guided by section 130.5 of 2022 Title 24 as well as section 2.3 of this utility metering document.
- Note: for an eGauge installed on a two-pole circuit that is fed by a 3 phase 120/208V feed, any phase being monitored must also be fed to the eGauge as voltage reference.

TABLE 3. Natural Gas Meter Specifications

UTILITY	Rating (Actual Cubic Feet/Hour)	MANUFACTURER
Natural Gas	≥1000 ACFH	Dresser Natural Gas Solutions Series B3 Rotary Meter*
	<1000 ACFH	Elster American*

Notes:

- All Natural Gas meters shall be connected to a SCADAmetrics Ethermeter EM-100 which in turn should be connected to the Campus Network.
- All registers must have a Solid State Dry Contact Type A Pulse Output installed and connected to an Ethermeter device which in turn connects to the SkySpark server through the Campus Network.
- Registers must read in cubic feet (CF) with a minimum resolution of 1 CCF.
- Registers must include a visual totalizer.
- Circular flanges must be installed.
- For pressure regulating valve (PRV) guidance see campus detail for gas meter set
- Meter registers shall have a temperature-compensated counter, if available for that model.
- Rotary meters are preferred over diaphragm meters where size and rating allow.
- Meter case should be rated at 25 psi for systems <1000 ACFH

*or equal

TABLE 4. Water Meter Specifications

UTILITY	SERVICE	SUGGESTED MANUFACTURER	SUGGESTED MODEL / MINIMUM REQUIREMENTS	MINIMUM DETECTABLE FLOW REQUIREMENTS
Potable Water (W), Irrigation (I), Reclaimed Water (RW)	Domestic, Residential, Industrial	Badger Meter	E-Series Ultrasonic with Orion LTE-M Cellular Endpoint	⅝″ - 1″: 0.25 gpm
				1 ½″ - 2″: 0.5 gpm
				> 2″: 0.75 gpm
Sewer Wastewater (WW)	Sewer Wastewater	Hach	FLO-DAR AV sensor with Hach FL1500 series flow monitor with communication to the Campus Network.	N/A

Notes:

- Meters must be connected and communicated to the campus Beacon AMA platform via a Badger Meter ORION LTE-M Cellular Endpoint or similar. Coordinate with Energy Management for frequency programming.
- Meters must be installed with new stainless steel bolt kits and new gaskets.
- Non-potable (Reclaimed) and Irrigation water must be sub-metered separately.

TABLE 5. HHW, CHW, and CW Meter Specifications

UTILITY	SERVICE	PIPE SIZE	MANUFACTURER	MODEL
Heating Hot Water (BHW) Chilled Water (BCH) Condensing Water (BCD)	Plant process Building use Equipment sub-metering	0.5” to 20”	FLEXIM	FLUXUS F721

Notes:

- Connect to campus BMS system and the SkySpark server via Campus Network. BACnet over IP is preferred.
- Building process utility meters must be included in the scope of all new construction or major modification/renovation projects, along with any associated work or personnel necessary to network the meter and set up trending of appropriate data points.
- Metering equipment installed for these systems must output the necessary parameters to calculate energy consumption (water supply temperature, return temperature, flow).

COMMISSIONING OF WATER UTILITIES 33 08 10

The Campus has developed a Standard Specification Section 33 08 10 Commissioning of Water Utilities. The specification shall be modified by the Design Professional to meet project requirements. An electronic copy (Word document) is available, contact the University’s Representative.

COMMISSIONING OF SANITARY SEWER UTILITIES 33 08 30

The Campus has developed a Standard Specification Section 33 08 30 Commissioning of Sanitary Sewer Utilities. The specification shall be modified by the Design Professional to meet project requirements. An electronic copy (Word document) is available, contact the University’s Representative.

CAMPUS WATER DISTRIBUTION SYSTEM **33 11 00**

CAMPUS WATER DISTRIBUTION SYSTEM MASTER PLAN

Refer to the Domestic/FP Water Master Plan under project number 11409-002D. Included in this document is hydraulic capacity modeling of the existing system and also modeling for the projected growth scenario under the 2020 LRDP.

REFERENCED CODES AND STANDARDS

Unless otherwise indicated in these standards, all work for the campus water system shall be designed and installed in accordance with the most recent editions of the following standards:

1. California Building Codes, Title 24, parts 1 through 12 as applicable.
2. California Code of Regulation Titles 17 and 22.
3. National Fire Protection Association (NFPA) 13 and 24.
4. These Standards - Campus Design Guides
5. Water System Standard Specification Parts 1,2, & 3 by the City of Santa Cruz Water Department
    a. The term "City" shall be replaced by "UCSC" wherever it occurs in the above document. b. The term "Engineer" shall be replaced by "Engineering Services, Physical Planning, Development & Operations" wherever it occurs in the above document.
6. American Water Works Association (AWWA) Standards

In cases where a conflict occurs between standards, inform the University for written direction. Absent of the University Representative's written direction, the above order shall establish precedence.

SYSTEM OVERVIEW

UCSC owns and operates a combined private fire & potable water system that provides service for all buildings on the main campus. The system is composed of approximately 20 miles of pipe with pipe sizes up to 14-inch diameter. The campus water system has eight (8) separate pressure zones isolated through 13 pressure-reducing valve (PRV) stations. A 1,000,000-gallon emergency water storage tank is located at the system high point near the highest elevation on campus. The campus water system is supplied by water from the City of Santa Cruz Water Department at five locations along Empire Grade. The water points of entry from the City are all metered and backflow protected by reduced pressure principle backflow devices.

The City's water system serving the campus is composed of an eight (8) inch City main that was installed specifically for the Campus starting in the 1960's and is run in Empire Grade. Water is pumped from the City's 12-million-gallon Bay Street facility that is located on Cardiff Place at the base of campus. This facility formerly contained a 39-million-gallon reservoir which was demolished beginning in 2007 and, by the end of 2015, was replaced with two six-million-gallon tanks. The water is pumped to three consecutive in-line City-owned water storage tanks at separate elevations all in the vicinity of Empire Grade. The City of Santa Cruz (SC) reservoir, SC Reservoir No. 2, is 1 million gallons and is located just north of the entrance to the Arboretum at elevation 426 feet. This reservoir supplies UCSC's 1-inch Barn Theatre connection plus other connections serving off-campus areas controlled by the City. At SC Reservoir No. 2, a City-owned pump station (University Pumping Station No.4) pumps water to SC Reservoir No. 4 which is 400,000 gallons and is at an elevation of 748 feet and supplies UCSC's six (6) inch Arboretum and 14-inch Heller Drive turn-outs. SC Reservoir No. 4 is located on the west side of Empire Grade across the ravine to about Kresge College. At SC Reservoir No. 4 another City-owned pump station (University Pump Station No. 6) pumps water to SC Reservoir No. 5. SC Reservoir No. 5 is a 2-million-gallon tank at elevation 982 feet which in turn supplies UCSC's 12-inch Pump Station and 14 inch Cave Gulch turn-outs. At the UCSC 12-inch Pump Station turn-out the University-owned pump station pumps water to the University-owned 1 MG Emergency Water Storage Reservoir at elevation 1113 feet.

The pressure zones on the campus water system are necessary to accommodate the system elevation changes are laid out as follows:

Zone 1: Lower campus starting at elevation 302’ at the intersection of Bay and High streets.
Zone 1a: Arboretum, Farm, Bird Project
Zone 1b: Barn G, Garage, Receiving, Cook House, Carriage House, Faculty Housing
Zone 1c: Ranchview Terrace

Zone 2: To elevation 420’
Zone 2a: Oakes College, Family Student Housing
Zone 2b: College 8, Housing Admin. Building, West Field House

Zone 3: Elevation 420’ to 660’
Zone 3a: Performing Arts/Visual Arts area, University House
Zone 3b: Stevenson and Cowell Colleges, Classroom Unit I, Whole Earth, Bay Tree Bookstore, Upper Quarry, Hahn Student Services

Zone 4: Elevation 660’ to 900’

Zone 5: Elevation 900’ up to UCSC’s Emergency Storage Reservoir at elevation 1113’

The zones are interconnected with pressure reducing stations. Static pressures can range from a low of roughly 35 PSI at the high point of a zone to a high of roughly 130 PSI at the low point of a zone. When planning new connections to the campus water system, UCSC shall be consulted for the pressure and other data specific to the proposed point of connection.

WATER MAIN SYSTEM EXTENSIONS

Definition: For the purposes of these standards, a water main shall be defined as any portion of a water pipe serving two or more building services or two or more fire hydrants.

Design: All water main extensions shall be designed and stamped by a civil engineer registered in the state of California. All design, work, and materials described herein shall be approved by the Designated Campus Fire Marshal (DCFM) as certified by the Office of State Fire Marshal (OSFM) and reviewed by Campus Engineering Services and Physical Plant Plumbing Shop.

Drawing Requirements:

1. Utility Conflicts: Where water system pipes have conflicts with other utilities, a detail or profile shall be shown on the plans, or the plans shall be sufficiently annotated to give clear direction for the installation. Drawings shall show the plan and profile details of the connection to existing mains. Details shall accurately show any depth transitions or fittings required to make connections. Any deviation in alignment (horizontal or vertical), such as an under-crossing or over-crossing, shall be noted on the plans and contain a detail specific to each location. The detail shall show plan and profile views and include all relevant details, such as modified backfill materials, air vacuum/release valves, fittings, and type of pipe.

2. New Tie-Ins: Plans shall note the location of all tie-ins and the type of shutdown required, i.e. routine, large, or major. Valves shall be numbered per the University valve numbering system;

consult with the University's Representative for requirements.

Water mains shall be designed with the following key features:

1. Water mains shall be designed in a loop configuration with two points of connection (POCs) to the existing campus water main system. These will be within the same pressure zone.
2. In creating looped connections adequate consideration for flushing the lines for water quality purposes shall be considered, this could result in the placement of isolation valves and additional hydrants that are specific for developing a flushing sequence.
3. New POCs to existing mains shall be installed with a new flanged ductile iron tee and a valve in each direction to establish a three-valve cluster.
4. Hot taps may forgo the three-valve cluster requirement. Hot taps will be approved on a case-by-case basis by the University Representative and Campus Engineer.
5. Provide isolation valves at a maximum spacing of 1000 feet along water mains.
6. Provide combination air/vacuum release valves at all system high points.
7. Provide blow-offs at all system low points.
8. Provide fire hydrants at a maximum spacing of 400 feet along water mains, or as required for compliance with California Fire Code, Appendix C.
9. Provide a water quality sample tap station connected to the system main for each new building complex.
10. Provide a new water PRV Station when a water main crosses a pressure zone elevation boundary or when required to maintain system static pressure below 150 PSI. Water PRV stations shall be equipped with two parallel PRVs; one a direct acting PRV, sized to regulate domestic water flow and the other a sustaining PRV sized at full pipe size to allow for maximum fire flow. The pressure control set point for the fire water PRV shall be set slightly below the set point for the domestic water PRV. Additionally, the PRV station shall include:
    a. A full-size bypass pipe with manual valves parallel to the PRVs.
    b. Manual valves upstream and downstream of the PRVs.
    c. Concrete base pad.
    d. Fenced enclosure on all sides and top.
    e. All appurtenances as were included for the PRV stations in UCSC Project 9068, Campus Utilities – Infrastructure Improvements, Phase One; Domestic / Fire Protection Water. Consult UCSC for further information.
    f. All PRV's to have factory double unions or flanges.

Sizing of Water Main:

Prior to Design: The Civil Engineer shall request from the UCSC Physical Plant Plumbing Shop the last known flow test at the nearest fire hydrant to the new proposed water main connection and extension. If the information is outdated, it should be determined if a new flow test is required. The final information used for design shall be documented in the single-line diagram.

Water mains shall be sized so as to be capable of achieving the fire flow requirements for all buildings and hydrants as called out in the current California Fire Code and in consideration for maintenance of water quality. An allowance shall be included for all future buildings planned for the area being served.

Confirm future buildings planned for the area with the University's Representative. In no case shall a water main be sized smaller than 8 inches in diameter. The proposed system shall be hydraulically modeled using computer-based software. The H2ONET modeling software was used on the most recent water master plan and is generally recommended. The new model shall reference nodes and data from the most recent existing model. Other modeling software may be considered subject to the approval of the University's Representative and provided all data from the most recent existing model is converted to the new format. The following system design criteria shall be used in designing the system extension:

1. Minimum allowable pressure at peak hour demand: 50 PSI
2. Minimum allowable pressure at maximum day with fire flow: 20 PSI
3. Maximum allowable service pressure: 150 PSI
4. Maximum allowable pipe velocity at maximum day with fire flow: 10 FPS
5. Fire flow requirements are set by the existing buildings on campus and within the respective zones as follows, refer to California Fire Code for building and site flow requirements for new structures:
    a. 3,000 GPM at no less than 20 PSI during maximum day conditions for Zones 1, 2, 3, and 5.
    b. 4,250 GPM (fire flow requirement at the McHenry Library) at no less than 20 PSI during maximum day conditions for Zone 4.
    c. 750 GPM sprinkler flow requirement at no less than 50 PSI for Zones 1 and 5 (to ensure 40 PSI minimum at the top floor of 2 story building).
    d. 750 GPM sprinkler flow requirement at no less than 60 PSI for Zones 2, 3, and 4 (to ensure 40 PSI minimum at the top floor of 4 story building).

NEW WATER SERVICE CONNECTIONS

All new service connections shall be requested to and accepted by the . Provide the following information: use, size, POC, fixture units (total GPM), and fire flow requirements.

Services shall be fed from looped water mains with the required three-valve cluster so that the likelihood of a building shut down due to a water main break is minimized. Each structure shall have a dedicated service connection and each service connection shall be metered. Domestic, non-potable, and irrigation water uses shall be individually metered.

Backflow Protection:

A reduced pressure principle backflow protection device shall be installed for: each irrigation connection, each science building industrial water connection, each domestic water connection for privatized development, or other entity where UCSC will not be in control of the day-to-day operation, any connection deemed to have a high probability for contaminated backflow by the or UCSC EH&S Department.

Service Connections:

1. Small (2-inch) – Concentric tapping sleeve with 2-inch flanged, operable, resilient seated gate valve and concentric pipe reducer downstream to service size.
2. Medium (2-inch) – Concentric tapping sleeve with a 2-inch flanged, operable, resilient seated gate valve on service at main
3. Large (>2 inch) – Three valve tee cluster, all flanged & operable.

4. The fire service line shall be an independent connection that serves the internal fire suppression system of a building.
5. PRV – due to the significant elevation changes on campus, the design professional shall evaluate the need for a PRV on each building's domestic & irrigation services to limit the pressure to less than 80 PSI.

MATERIALS

All piping, valves, and appurtenances shall be lead-free and rated for a 200 PSI minimum working pressure and rated for direct burial or pit installation. Any non-metallic pipe shall be provided with a 10 gauge tracer wire. Refer to Campus Design Guide Standard Utility Trench Detail.

Acceptable piping materials include:

1. AWWA C-900 PVC Pipe with restrained joints, underground 4 inches and larger
2. Ductile iron pipe, cement lined with restrained joints, underground 4 inches and larger
3. Type-K Copper Tubing with brazed joints (Underground under 4 inches)
4. Nuts and bolts of mechanical joints shall be 316 stainless steel.

No galvanized pipe or fittings. No black steel pipe or fittings. PVC pipe with solvent weld joints shall not be used for campus water systems other than irrigation service downstream of the main shut-off valve, meter, and backflow preventer.

Fire hydrants shall be U.L. approved, bronzed bodied, wet barrel type with a 6-inch inlet, one 4-1/2 inch steamer outlet, and two 2-1/2 inch hose outlets. All outlets shall have National Standard Hose Threads and shall be protected with bronze caps chained to the hydrant. Fire hydrants shall be wet barrel fire hydrants complying with ANSI/AWWA C503. Provide a gate valve with a valve box at the connection of hydrant piping to the main water line. Fire hydrants shall be painted yellow, with two coats factory factory-applied paint over primer.

Valves:

All water distribution system valves, water supply valves, and fire system supply valves, including valves over 12 inches, shall be rated to a minimum working pressure of 200 PSI. All valves shall open by turning the stem counterclockwise. Buried valves shall be non-rising stem with double o-ring seals equipped with a 2-inch square operating nut. The exterior shall be bituminous or epoxy-coated. Buried valves shall have stem extensions to place the operating nut within 6 inches of the top of the value box. Valve boxes shall be precast concrete valve boxes with a cast iron ring and lid, rated for H20 loading. Provide an eye bolt for the valve identification tag within the top 3 inches of the valve box. Valve boxes and extensions shall be installed so that no loads are transferred to the valve, valve body, or pipe. All valves shall be suitable for frequent operation as well as service involving long periods of inactivity. Valves shall be capable of operating satisfactorily with flows in either direction and shall provide zero leakage past the seat. End connections shall be flanged. The Contractor shall provide the manufacturer's affidavit of compliance per AWWA.

1. All gate valves 3 inches through 12-inch nominal diameter shall be resilient seat gate valves, manufactured in accordance with AWWA Standard Specification C509, with the following requirements or exceptions: Valves shall be cast iron body, resilient seated wedge with nonrising stem. Gate valves shall be installed vertically in buried, horizontal water lines without gearing, bypasses, rollers, or tracks. The diameter of the stem and number of turns to open shall conform to Table 4 of AWWA Standards C509. The stem seal shall consist of two o-ring type stem seals in accordance with Section 4.7 of AWWA Standard C509. Bonnet and gland bolts shall be either fabricated from low alloy steel for corrosion resistance or electroplated with zinc or cadmium. The hot-dip process in accordance with ASTM Designation A153 is not acceptable. Flanges shall

comply with Section 4.4 of AWWA Standard C509. Flanges shall be machined to a flat surface with a serrated finish in accordance with AWWA Standard C207. All exterior ferrous surfaces, except the flange faces, shall be evenly coated with black asphalt varnish in accordance with Section 5.3 of AWWA Standard C509, or epoxy in accordance with AWWA Standard C550. All interior ferrous surfaces, including the inside of the wedge, shall be evenly coated with epoxy in accordance with AWWA Standard C550. Epoxy coating shall be applied to a minimum thickness of 4 mils. Flange faces shall be shop coated with a rust preventive compound, Dearborn Chemical "No-Ox-Id", Houghton "Rust Veto 344", or Rust-Oleum "R-9".

2. All butterfly valves 14" and above shall be rubber seated butterfly valves, manufactured in accordance with AWWA Standard C504, with a side-mounted gearbox, designed for buried use.

Valve boxes shall be Heavy Traffic rated, precast concrete with cast iron traffic covers. The traffic box shall be circular. Confirm with the University Representative that valve boxes subject to vehicular traffic shall be G03 while those not subject to vehicle traffic can be G05.

1. The word "WATER" shall be embossed on the top of all valve box lids. Lids for dedicated valves shall be labeled as follows:
   a. Building fire suppression systems "FIRE SERVICE" or "FIRE"
   b. Irrigation service "IRR"
   c. Fire Hydrant "HYDRANT"
   d. Blow off "BO"
   e. Air/vacuum vent "AVV"
   f. Non-potable Water (to include Reclaimed Water) "NPW"
   g. Seawater supply "SWS"
   h. Sample station "SAMPLE TAP"
   i. PRV Bypass or normally closed valve "BYPASS N/C"

Approved reduced pressure principle backflow prevention assemblies (as per City of Santa Cruz Water Dept.):

1. Shall be equipped with resilient seated shut-off valves and ball valve shut-offs on test cocks. Shall be supplied as a complete assembly. Stainless Steel Zurn 300AR series or equal.
2. A current list of approved manufacturers and models is available from the City of Santa Cruz.
3. Components in the backflow prevention assembly shall only have non-ferrous materials in direct contact with internal water.

EXECUTION

Large or critical-use facilities require dual service connections. All domestic services shall have a valve immediately ahead of the water meter location. Minimum service size is one inch. Service connections shall be:

Service Size	**Hot tap permitted**	**At the main line connection point**
<2-inch	Yes	Concentric tapping sleeve with 2-inch resilient seated gate valve and downstream pipe reducer to reduced service size on service line
2-inch	Yes	Concentric tapping sleeve with 2-inch resilient seated gate valve on service line
>2-inch	No*	Three valve tee with resilient seated gate valve to service size*

*If mainline isolation valves are already present nearby, the may allow services to be installed with a hot tap with a full circumference concentric tapping sleeve and a resilient seated gate valve on the service line. Use stainless steel JCM 432 tapping sleeve or equal.

Three valve tees shall have two valves on the main upstream and downstream of the tee and one outlet to service the new service connection; see University's Standard Drawing Tee Connection. Flexible connections shall be used when connecting to asbestos cement pipe.

The domestic water service to the building or facility shall include a pressure regulator, meter, and bypass installed outside and above grade. Riser to be located outside of building footing and enter building above grade. Reference Campus Design Guide Standard Details.

Irrigation water services shall include a bronze PRV with strainer & double unions or flanges, meter, and reduced pressure principle backflow prevention device installed outside and above grade. Provide a housekeeping pad. Reference Campus Design Guide Standard Details.

All new lateral services shall provide a three-valve cluster: one valve upstream of the tee, one valve downstream of the tee, and one valve at the services lateral, all the same size.

Asbestos Cement (AC) Pipe:
All cutting, handling, and disposal of asbestos cement pipe shall be done in compliance with all applicable laws and regulations. To prevent settlement and damage to existing AC pipe, any excavations below AC pipe shall require:

1. Removal of a section of AC pipe and replacement with new. Confer with University Representative.
2. Existing, exposed AC pipe: Provide cement slurry backfill against undisturbed soil to support AC pipe (maximum of 2 feet depth of slurry backfill allowed). Two sack mix is required.

"Minimum Cover" is the distance from the top of the pipe to the final finished grade measured directly over the pipe. For mains, branch, and service connections, the minimum cover standard shall be 30 inches. Refer to Campus Design Guide Standard Utility Trench detail. Where cover is less than standard, or greater than 7 feet, written approval from the University's Representative is required. Where the cover is less than the standard, ductile iron pipe is required.

Mechanical Restraints:
Provide the number of restraints and pipe length per manufacturer's table at changes in pipe direction, changes in pipe sizes, dead-end stops, and at valves. New plastic pipe installations shall use restrained joint fittings. Thrust blocks shall only be used if connecting to existing unrestrained pipes or fittings and be explicitly shown on the plans, including location and thrust block size. Provisions shall be made to ensure that pipe joints, fittings, and valves are not covered by the thrust block concrete with plastic or bituminous material between pipe and fittings for future access for repair or replacement.

Separation from Other Utilities:
For utilities not covered by State Health Standards, the separation between water lines and other utilities, such as pipes, vaults, and manholes, shall never be less than 1 ft.

Testing and Inspection:

1. Pressure test piping to 200 P.S.I. for 4 hours with leakage limited to one gallon per hour per 1000 L.F. of installed pipe, (or a drop in pressure of no more than 10% maximum in two hours).
2. All Contractor requests for onsite inspections by the campus Fire Marshal to test fire protection systems shall allow for a minimum of two weeks' notice.

3. Thrust blocks shall be neatly formed and inspected by the Inspector of Record for domestic water or the Fire Marshal for fire water before backfilling. Use plastic sheeting between concrete and fittings.

FIRE SUPPRESSION WATER DISTRIBUTION LATERALS 33 11 19

Refer to the Campus Water Distribution System Master Plan disclosed in section 33 11 00.

The Engineer of Record shall request a fire flow test at the nearest fire hydrant to the new proposed water main extension. The final information used for design shall be documented in the single-line diagram. A fire flow test shall be required at the end of construction for record.

All work shall be designed in accordance with the requirements of the Santa Cruz Fire Department (SCFD) and Designated Campus Fire Marshal (DCFM). Coordinate approval by SCFD/DCFM with the University's Representative. Refer to applicable sections of 33 11 00 Campus Water Distribution. Refer to Division 28 31 00 Fire Detection and Alarm and coordinate the electrical conduit installation for supervisory systems. See Section 21 00 00 Fire Suppression for information on valves and additional requirements.

SUBMITTALS

Underground fire protection system shop drawings shall show all information required by NFPA 24. In addition, the shop drawings shall show the Soil Bearing Capacity and the location, design, and size of mechanical restraints.

MATERIALS

All material shall be currently listed in the Underwriters Laboratories, Inc., Fire Protection Equipment List, and/or the Factory Mutual Approval Guide for use as intended in underground fire line installations and shall be acceptable to the SCFD/DCFM. Material pending approval shall not be acceptable.

Piping installed within 5 feet of the building shall be ductile iron. Fire services under footings or through slabs are prohibited.

Uniflanges shall not be used on vertical piping, above ground, or in the basement. Tops of vertical risers shall be rodded down to the 90-degree bend at the base of the riser. Horizontal risers shall be rodded back to a deadman of sufficient size to secure the flanged fitting.

Double Detector Check Valve Assembly and Fire Department Connection (FDC):

A stainless steel double detector check valve assembly is required on all fire lines. Refer to the Campus Design Guide Standard Detail - Double Check Valve Assembly with FDC Service - for more information.

1. The location of this assembly shall be approved by the Campus Architect and Designated Campus Fire Marshal. Locate the assembly outside of the building in an accessible service area and not in a highly visible location.
2. Assembly shall be FM Global, CSFM, and/or UL listed for fire protection service.
3. Where subject to mechanical injury, protection shall be provided. The means of approved protection shall be arranged in a manner, which shall not interfere with the connection to inlets.
4. Fire department connection (FDC) shall be located just downstream of above grade double-check assembly not less than 40 feet from the buildings and property protected. The double detector check valve and the fire department connection shall be clearly visible and accessible from the street. The fire department connection shall front the street of primary fire department vehicular access and shall be located within 25 feet of a fire hydrant. Fire department connection inlets

shall be located 30 to 36 inches above grade on the street front and as measured at all inlets within a three-foot radius. Note: Where conditions do not permit, the fire department connection shall be placed where it will be readily accessible in case of fire and not liable to injury. All fire department connection locations shall be per the state-adopted NFPA 24 and approved by the Designated Campus Fire Marshal.

   a. Systems with a flow demand of 500 GPM or less: Provide four-inch pipe mount by 2-1/2 inch (Siamese), brass, dual clapper, freestanding fire department inlet connections, one-inch cast lettering, brass finish with plugs and chains or sensible caps.
   b. Systems with a flow demand greater than 500 GPM: Provide six-inch pipe mount by 2-1/2 inch, 4-way, brass, four-clapper freestanding fire department inlet corrections, one-inch cast lettering, brass finish. Inlet corrections shall be oriented in a quad arrangement.

5. Maintain a 5-foot clear radius around the fire department connection. Grade variation within this radius shall not exceed 1:12. The fire department connection shall be arranged so that hose lines can be ready and conveniently attached to inlets without interference from any nearby objects including buildings, fences, posts, or other fire department connections.
6. Underground piping serving the fire department connections shall be wet pipe under system pressure with a serviceable check valve at each fire department connection. Do not install check valves in vaults.
7. No galvanized or black pipe for pipe or fittings on underground fire systems. Use ductile iron or C900 with ductile risers. Threaded nipples, pipe, or fittings to be brass or 316SS.
8. Paint all above grade building fire services with 2 coats of contrasting paint per adopted state NFPA requirements per the state of California. Paint shall be Rustoleum 9100 System DTM Epoxy Mastic, or equal. Confirm color with University Representative.
9. For FDCs, provide a building identification sign as approved by the Designated Campus Fire Marshal.

INSTALLATION

Piping shall be installed as per the requirements of this Division and in a manner acceptable to the SCFD/DCFM and the University's Representative. Give special attention to materials and coatings.

Provide mechanical restraints. Thrust blocks to be used on a case by case basis and require PPDO Engineering approval. Thrust blocks are required for Fire Hydrant riser installations. The depth of bury for piping shall be a minimum of 36 inches under vehicular paving. Measurement is from the top of the pipe to the grade.

System risers shall come up and over building foundations and are not allowed to pass under building foundations.

INSPECTION & TESTING

Inspections are required by the SCFD/DCFM and the University's Representative. An inspection of the underground installation, back flush, and hydrostatic test shall be conducted by the Contractor and witnessed by a representative of the SCFD/DCFM and the campus Inspector of Record prior to backfill. Disinfect line from point of connection to Building Fire Protection as per Section 33 13 00 Disinfection of Water Distribution Systems.

All piping shall be hydrostatic-pressure tested in accordance with these standards, and NFPA 24-latest edition, as amended. Underground piping shall be center-loaded and all fittings, joints, strapping, and thrust blocking shall be exposed for hydrostatic pressure testing and inspection per NFPA 24.

The contractor shall prepare and complete NFPA 24 inspection and installation certificates prior to acceptance testing and have them signed off by the SCFD/DCFM and the University's Representative immediately after acceptance testing and approval.

DOMESTIC WATER PIPING DISINFECTION	33 13 00

The Campus has developed a Standard Specification Section 33 13 00 for Domestic Water Piping Disinfection. The specification shall be modified by the Design Professional to meet project requirements. An electronic copy (Word document) is available, contact the University's Representative.

CAMPUS SANITARY SEWER UTILITY	33 30 00

CAMPUS SANITARY SEWER MASTER PLAN:

Refer to the Sanitary Sewer Master Plan Project 11049-002A (covers main campus only).

SYSTEM OVERVIEW:

UCSC owns and operates the sanitary sewer system that provides service for all buildings on the main campus, Westside Research Park, the Coastal Science Campus, and other off-campus facilities. The main campus system consists of approximately 12 miles of gravity pipe, ranging in size from 6-inches to 15-inches. The system contains two distinct trunks, the 12-inch west trunk, and the 14-inch east trunk. The system includes approximately 400 manholes. Grease interceptors have been installed at all the major kitchens to meet the City of Santa Cruz wastewater treatment requirements. The system also includes several lift stations to pump flow either from low-lying areas or the basement floor of buildings. The majority of the system was constructed in the 1960s as part of initial campus development. Extensions were added with the development of major colleges and buildings. Gravity pipe materials used in the system have included: concrete cylinder pipe, vitrified clay pipe (VCP), PVC pipe, and ductile iron pipe. Known maintenance problems with the system have included: root intrusions, pipe sags, and substandard drop inlets. All flow is combined at the base of campus (near the Cook House Building) where its flow is measured by a University-owned flume meter and then discharged to the City's system which continues down Bay Street eventually arriving at the City of Santa Cruz Wastewater Treatment Facility.

REFERENCE CODES AND STANDARDS:

Unless otherwise indicated in these standards, all work for the campus sanitary sewer system shall be designed, installed, and maintained in accordance with the most recent editions of the following standards.

1. California Building Codes, Title 24, parts 1 through 12 as applicable.
2. California Code of Regulation Titles 17 and 22.
3. These Standards
4. The Greenbook; Latest edition of the Standard Specifications for Public Works Construction by Public Works Standards, Inc.
5. State Water Resources Control Board Statewide General Waste Discharge Requirements for Sanitary Sewer Systems Order NO. 2006-0003-DWQ and the Revised Monitoring and Reporting Program Order NO. 2013-0058-EXEC

In cases where a conflict occurs between standards, the above order shall establish precedence.

SEWER SYSTEM MANAGEMENT PLAN

UCSC is enrolled in the State Water Resources Control Board Statewide General Waste Discharge Requirements for Sanitary Sewer Systems, check the State Water Board website for the current Order and the Revised Monitoring and Reporting Program Order NO. 2013-0058-EXEC. UCSC manages, operates, and maintains the sanitary sewer system as outlined in the Campus Sewer System Management Plan.

DEFINITIONS / ABBREVIATIONS:
ADDWF: Average Daily Dry Weather System Flow
Lateral: Sanitary sewer pipe serving a single building and connecting to a sewer main.
Main: Sanitary sewer pipe with two or more laterals connected to it.
MDDWF: Maximum Daily Dry Weather System Flow

PHDWF: Peak Hour Dry Weather System Flow

PHWWF: Peak Hour Wet Weather System Flow

SS: Sanitary sewer

SANITARY SEWER MAIN EXTENSIONS:

Design: All sanitary sewer main extensions shall be designed and stamped by a California Licensed Civil Engineer. For new tie-ins to the existing sanitary sewer system, perform a video inspection.

Refer to Section 33 40 00 Campus Stormwater Utilities for requirements that directly affect the design of Campus Sanitary Sewer Utility and Campus Standard Specifications 33 08 30 Commissioning of Sanitary Sewer Utilities.

Capacity Modeling: Sanitary sewer capacity modeling shall be included within the design process for those projects where development is different than the scenario modeled in the Sanitary Sewer Master Plan. For these projects, the existing model shall be updated to reflect the actual development. The model shall include likely future flow contributions in addition to the current project. The model shall evaluate the capacity for all lines.

DESIGN CRITERIA

SS Main Minimum Pipe Size: 8 inches, With approval of the , an exception to use 6 6-inch pipe may be allowed when it can be demonstrated that a run is unlikely to have future additional loads and all other design criteria have been met.

Minimum Pipe Slope (Prescriptive Method): 2%

Pipe Slope (Engineered Method): Based on a hydraulic design using the following criteria:

1. Mannings Equation: "n" = 0.013 minimum for all pipe materials
2. Minimum Velocity: 2 FPS at average flow conditions
3. Maximum Velocity: 12 FPS at peak hour flow conditions
4. Maximum percent full criteria (d/D)
5. Pipe diameter 10-inch and less = 0.50
6. Pipe diameter greater than = 0.75

Acceptable SS Pipe Materials:

1. SDR 26 PVC Gravity Sewer Pipe
2. Fusible PVC pipe
3. HDPE butt fused pipe

Pipe Materials Not allowed:

1. SDR 35 PVC pipe
2. Vitrified Clay Pipe

3. Asbestos Cement Pipe

Manhole Locations: Manholes shall be located at a maximum spacing of 300 feet along SS mains, at each change in either horizontal or vertical direction of the main, and at each SS lateral connection to the main.

Drop Manhole Criteria: Provide drop manholes only when required due to site conditions and upon UCSC Engineering Services and UCSC Physical Plant Plumbing Shop approval.

Sanitary Sewer Manholes:

1. A manhole is required at every horizontal or vertical change in alignment.
2. Maximum distance between manholes is 300 feet.
3. A manhole is required at the end of every main.
4. Manholes shall be constructed with eccentric cones.
5. The manhole shall be designed such that the angle in the horizontal plain between the downstream and any incoming sewer is a minimum of 90 degrees.
6. Stubs provided out of manholes for future extension shall have full-size rodding inlets provided when more than 20 feet of pipe is installed or where service laterals are connected to the stub.
7. Standard drop manhole installations are required when the difference in elevation between the incoming and outgoing sewer is greater than 2 feet. While not encouraged, drop manholes may be required because of some physical restraints. They may not, however, be used to merely avoid the extra depth of trenching unless unusual circumstances exist. Upstream slope changes shall be used to avoid the need for a drop manhole. Reference Standard Details of the Campus Design Guide.
8. When one drop connection is required, use a 60-inch diameter manhole. When two or more drop connections are required, use a 72-inch diameter manhole.
9. Fixed ladders may be required. Confirm with University Representative.

Slopes through Manholes:

1. When sewers of uniform slope pass through a manhole, the slope shall be maintained and the invert at the center of the manhole shall be given.
2. When sewers change slope at a manhole, incoming and outgoing invert elevations shall be given.
3. Provide sufficient drop through a manhole to compensate for energy loss caused by the change of alignment. A minimum drop of 0.1 foot is required for a change of alignment greater than 30 degrees.
4. When pipe sizes change at structures, design the inlet crown at least as high as the outlet crown.

Connection to Existing Campus Sewer Main

1. Connect new mains at existing manholes or by constructing a new manhole over the point of connection. Saddle connections are prohibited.
2. Where an existing sewer main is to be extended, remove the existing plug, clean out, or rodding inlet, and install a manhole. The main may be extended without installation of a structure only if it is on the same line and grade, the pipe size and material are the same and the manhole spacing is adequate.
3. Elevations of mains connecting to existing sewer mains shall be as follows:
    a. Side sewer mains connecting to an existing main at an angle of 30 degrees or greater shall be at least 0.1 foot higher than the existing.
    b. Connect sewer mains so that the crown of the smaller main is no lower than the crown of the larger main.

c. Connections to Trunk Sewers shall be made so that the invert grade of the new main shall be no lower than the crown of the Trunk sewer.

Sewer Force Mains:

1. Sewer force mains shall conform to the Water Construction Standards for water mains.
2. Sewer force mains shall be laid with a constant slope toward the pump station to allow for complete draining of the pipeline. Reference Campus Design Guide duplex-pump detail.
3. Cleanout boxes shall be placed at every horizontal change in alignment or a maximum of every 200 feet.
4. Boxes shall conform to valve box requirements per UCSC Campus Design Guide Standard Detail with the lids clearly marked, "SEWER."
5. Cleanouts shall be a full-size flanged resilient seated epoxy-coated gate valve with blind flange and 316 stainless steel hardware.

Alignment

1. Horizontal and vertical separation from Domestic Water lines shall conform to the State of California, Department of Health Services, "Criteria for the Separation of Water and Sanitary Sewer."
2. In general, design sewer mains in straight street sections to run parallel to the street centerline. All mains shall be a minimum of five feet clear from all buildings, building overhangs, etc.
3. In curved streets, design the sewer alignment generally on one side of the centerline to allow installation of other facilities such as water, storm drains, etc. without using transverse crossings. Provide an alignment such that no part of the sewer main is less than 1 foot from the lip of the gutter.
4. Vertical curves or bend fittings in gravity sewer mains are not allowed.

Laterals

1. Building laterals shall enter the main at a manhole. If two or more laterals tie together before the main, provide 2-way clean outs just upstream of each lateral/lateral connection.
2. Cleanouts: Pipe extension to grade with compression-type plug. Install curb box over riser pipe. Use precast concrete box Christy F8 with a cast iron lid or approved equal in non-traffic areas and Christy G5 with a cast iron lid or approved equal in traffic areas. Lids shall be marked "SEWER."
3. Lateral cleanouts shall be installed within 5 feet of the structure.
4. Sewer laterals serving buildings or facilities that have plumbing fixtures with flood-level rim elevations located below the next upstream sewer manhole rim require an approved backwater valve. Fixtures above such elevation shall not discharge through the backwater valve per UPC Section 409. Backwater valves shall be installed in a vault, pit, or basement so the valve is easily accessible for maintenance. A cleanout shall be installed within 5 feet downstream of the valve.

Other Waste Discharges

1. Sediment traps, grease interceptors, and sampling structures as may be required by the University shall be shown on the plans submitted for approval, and comply with Standard Details of the UCSC Campus Design Guide.
2. Food Service facilities shall have a grease interceptor installed outside the facility in an area accessible for service vehicles and maintenance staff. Locate the interceptor downstream as close to the building as is practical.
3. Trash enclosures and other outdoor pad areas used for washing shall be plumbed to the sanitary sewer system at a grease interceptor or other connection point approved by the University. Preventive measures shall be taken to eliminate the intrusion of any rainwater or surface runoff.

4. Wash pad areas must be diked and/or sloped so that the smallest area possible drains to the sewer. These areas must be covered to prevent rainwater intrusion and drainage to the sanitary sewer system
5. Concrete grease interceptors, sample stations, and the two subsequent downstream manholes shall be provided with epoxy-coating on all interior surfaces. Alternate materials, such as HDPE, are allowable upon approval from UCSC.
6. Grease interceptor odor control systems must be required.
7. Grease interceptor discharge must tie into the Sanitary Sewer in the shortest distance practical.
8. Grease waste systems & grease interceptors must have a vent system that is independent of the Sanitary Sewer System. Underground and above-ground pipe, fittings, and vents are to be HDPE or fused polypropylene.

Lift Stations

1. Lift stations shall not be allowed where an acceptable alternative gravity route exists. If a lift station is required due to the absence of an acceptable gravity route, only the lower level of a multi-level building may be on a lift station. The upper levels must use gravity routes if they exist.
2. Design the lift station to serve the entire tributary at build-out densities in accordance with the sewer system master plan, LRDP, and I/I allowances.
3. All pumps, regardless of station type, shall be non-clogging, and capable of passing a minimum 3 inches diameter sphere.
4. Lift stations are not allowed within the street.
5. Provide a 12-foot paved access road to allow service vehicles to be parked off the street and clear of the sidewalks. Turnarounds are required for stations constructed along heavily traveled streets. Provide service vehicle access to the wet well.
6. Provide a reinforced concrete base slab sized adequately to counteract buoyancy. Provide supporting design calculations.
7. Provide a single surface pad over the site that incorporates lift station access, wet well access, and supporting generator and fuel supply tanks, as necessary.
8. Provide restrained flexible couplings on all outlet piping within 2 feet of the station wall.
9. All wet well components and all items in the wet well shall be non-corrosive plastic, stainless steel, or other approved material.
10. Wet well to be a minimum of 72 inches in diameter with a 4-hour capacity or as necessary to accommodate pumping equipment for submersible stations. Provide resilient-seat gate valve on inlet pipeline into wet well to provide wet well isolation.
11. Odor control systems shall be required.
12. Provide 6 inch PVC emergency by-pass system consisting of a suction line and a discharge line and a standpipe equipped with a cap and cam-lock connector. Bypass shall be located in a vault. The standpipe connects to the force main through an AWWA resilient seat gate valve with stainless steel trim and a check valve. The suction and discharge lines shall have gate valves for isolation. Adequately support all piping.
13. Provide 1-inch minimum water service with reduced pressure backflow preventer and piping insulation. Provide hose bib connection.
14. Provide a minimum of two pumps and controls to alternate lead and lag pumping.
15. Provide hour meters for each pump that records pump run time, only if the motor is operating.
16. Provide a magnetic flow meter on the discharge of the pump station. Meters may be in an approved vault. The display shall be installed in the pump station control panel.
17. The lift station shall consist of a minimum of two centrifugal sewage pumps with grinder-type impellers, guide rails, wet well access, discharge seal and elbow, motor control center, starters, liquid level control system, high-level alarm, pump failure to start when commanded to start alarms, and all hardware necessary to make a complete working system. The high-level alarm shall enunciate when the wet well effluent level is within 24” of the top of the well. All pumps, motors, internal valves and piping, level indicators, and control panel, shall be assembled as a

package. Supply and warranty shall be through one company. Manufacturers: ITT Flygt, Gorman Rupp Company, or equal.

18. Coordinate with Division 25 for all lift station alarms to be monitored by the BMS system. The following minimum data points will be connected to the campus BMS system:
    a. High-Level Alarm
    b. Station Failure Alarm
    c. CMD status pump one
    d. CMD status pump two
    e. Status pump one
    f. Status pump two

Lift Station Piping and Valving

1. When not included with package stations, all internal main lift station piping shall be flanged or Victaulic to allow for disassembly. All installations shall allow for single pump operation of the lift station while the other pump is out of operation for maintenance, replacement, or repair.
2. All main piping shall have manual vents and drains to allow draining of sewage prior to piping disassembly.
3. Resilient-seat-gate valves shall be used in station discharge piping. 3-way valves are not allowed.
4. Main Pump Check Valves shall be cast iron swing checks with externally weighted lever return. The check valve shall not be installed in the vertical. Disc shall be 316 stainless steel or cast iron with bronze trim. The Pivot arm and bearing shall be 316 stainless steel or cast iron with bronze trim. Pivot arm and bearing shall be 316 stainless steel or bronze. Seat shall be field replaceable with neoprene facing.
5. Check valves and isolation valves shall be in a separate vault adjacent to the lift station vault and shall not be inside or over the top of the lift station vault.
6. Electrical Equipment:
    a. Free standing electrical service with transfer switch, with heavy-duty electrical weatherproof enclosure securely mounted in a manner acceptable to the University Representative and/or UCSC Physical Plant, a minimum of 36–inches above the ground. Provide a concrete pad around steel supports.
    b. All pump motors shall have solid-state soft starters. They shall be Allen-Bradley or equal and provided with solid state smart type motor starters with a pump control option used to provide ramp starting and stopping of motors. The controller shall have the following start modes: soft start with selectable kickstarts, current limit, and full voltage. Motor starters shall be capable of being operated in hand or auto modes (H-O-A).
    c. Interior Lighting: Provide all control panels with a fluorescent interior light of the same approximate width of the control panel located along the top of the panel. Provide light with a separate light switch.
    d. UPS: Provide an uninterruptible power supply sized for 150% of the calculated load with sufficient battery backup time for 30 minutes of operation. Provide American Power Conversion, Best Power Products, or equal.
    e. Selectors and Pushbuttons: Provide corrosion-resistant 30mm selectors and pushbuttons by Allen-Bradley or Square-D.
    f. Sewer lift station electrical controls shall comply with standards as established by the University's Representative to ensure compatibility with existing control and SCADA systems.
    g. Lift stations shall be served by standby power.
    h. Provide a 120-volt GFI service outlet within 10 feet of the lift station.

Submersible Pumping Stations

1. The lift station shall consist of a minimum of two submersible centrifugal sewage pumps, guide rails, wet well access, discharge seal and elbow, motor control center, starters, liquid level control system, and all hardware necessary to make a complete working system. Supply and warranty shall be through a single company. Manufacturers: ITT Flygt, Gorman Rupp Company or equal.
2. The pumps shall be self-priming, electric, submersible, centrifugal non-clogging units capable of passing a 3-inch sphere. The pump and motor shall be suitable for continuous operation at full nameplate load while the motor is completely submerged, partially submerged, or not submerged. All electrical equipment/panels shall be above ground.
3. Each pump shall be furnished with a discharge connection system, which shall permit removal and installation of the pump without the need for the operator to enter the wet well.
4. All hardware in the wet well, chains, cables, and slide rails shall be 316 stainless steel.

Testing & Inspection of Sewer Systems

1. Refer to Section 33 08 30, Commissioning of Sanitary Sewer for testing and inspection requirements.

CAMPUS STORMWATER UTILITIES 33 40 00

Refer to Integrated Water (Watershed/Non-Potable) Master Plan Project 11409-002I. Check with the University Representative for the most current documents. Also, refer to the September 2004 project 11009-005 Campus Stormwater/Drainage System Master Plan by Kennedy/Jenks.

SYSTEM OVERVIEW: The campus's storm drainage conveyance system is comprised of multiple types of engineered stormwater detention systems, urban contaminant removal systems, stormwater piping, catch basins, surface run-off, and swales that discharge to natural drainage elements including channels that bisect the campus and karst type features. The UCSC campus does not have an interconnected, campus-wide, piped stormwater drainage system typical of urban environments. Such a system is not necessary or desirable in the natural, rural environment found on campus. The typical development pattern – clusters of buildings separated by large natural ravines and groves of trees – lends itself to isolated systems, each of which must properly handle and treat storm runoff before discharging to natural drainage channels. Piped stormwater conveyance is typically limited to piping immediately around nonpermeable facilities, such as roads, walkways, and structures, as needed to direct flow and avoid damaging improvements before returning stormwater back to the natural environment.

See Appendix C of these standards for Post-Construction Stormwater Management Requirements. Contact the campus Stormwater Manager to discuss unique campus conditions related to drainage features and permitting. Contact information should be obtained via the assigned University Representative or the .

PIPED STORMWATER SYSTEMS

REFERENCE CODES AND STANDARDS:

Unless otherwise indicated in these standards, all work for the campus stormwater utilities shall be designed and installed in accordance with the most recent editions of the following standards.

1. California Building Codes, Title 24, parts 1 through 12 as applicable.
2. California Code of Regulation Titles 17 and 22.
3. These Standards

4. State of California, Department of Transportation, Highway Design Manual, Chapters 800 – 890 Highway Drainage Design, latest edition.
    a. Where the terms "State" or "Engineer" are used in the State Specifications, they shall be considered as meaning "UCSC" or "Engineering Services, PPDO."
5. State of California, Department of Transportation, Standard Specifications, Section 10 through 98; more specifically, Division VII Drainage Facilities
    a. Where the terms "State" or "Engineer" are used in the State Specifications, they shall be considered as meaning "UCSC" or "Engineering Services, PPDO."
6. State of California, Department of Transportation, Standard Plans; more specifically the Drainage sheets, no D71 through no. D102
    a. Where the terms "State" or "Engineer" are used in the State Specifications, they shall be considered as meaning "UCSC" or "Engineering Services, PPDO."

For further requirements related to Storm Water Facilities, refer to related Campus Standard Specifications including but not limited to Section 33 05 00, General Utility Requirements, Section 33 05 26, Utility Line Signs, Markers, and Flags, and 33 17 00, Non-Potable Water Systems.

DEFINITIONS / ABBREVIATIONS: Reserved

DESIGN QUALIFICATIONS:

All piped and/or controlled stormwater facilities shall be designed and stamped by a California Licensed Civil Engineer.

DESIGN REQUIREMENTS – STORMWATER MANAGEMENT

GENERAL

A. Protect all major springs, seep zones, drainage channels, year-round streams, and natural superficial drainage patterns from alteration. For new development and redevelopment, a 30-foot buffer from water bodies will be included in the project. Where a 30-foot buffer is not feasible and for buffers less than 30 feet, written documentation from a qualified professional must be provided prior to design approval to show that the proposed buffer is adequate to prevent adverse effects on the watershed.

Refer to the Karst Hazard Map to determine the potential impacts due to karst

B. Ensure that stormwater meets water quality requirements outlined in Appendix C - Post-Construction Storm Water Management Requirements before entering a natural drainage course or a karst feature such as a sinkhole.
C. Where new development drains to existing outfalls, the design team shall complete an engineering analysis of the existing outfall(s); this analysis shall include existing tributary areas, the new development, and any reasonably foreseeable future development which is also expected to share the same outfall facilities. Consult with the campus Storm Water Manager and the to determine scope details. All outfall facilities shall be upgraded as necessary to comply with current best practices and these standards; at a minimum, extend piped systems to the toe of the slope and provide energy dissipation which is sited and designed to minimize impacts (including visual ones) to the natural drainage course.
D. Where environmental conditions and engineering design allow, use soft armoring to minimize erosion in drainages.

MUNICIPAL PERMIT

A. Comply with the requirements found in the most recently adopted "State Water Resources Control Board, National Pollutant Discharge Elimination System (NPDES) General Permit for

Waste Discharge Requirements (WDRs) For Storm Water Discharges From Small Municipal Separate Storm Sewer Systems (MS4s) (General Permit)."

B. Comply with the most recently approved University of California Storm Water Program Guidance Document

POST-CONSTRUCTION REQUIREMENTS

A. All projects including new development or redevelopment projects that create and/or replace impervious surfaces are required to comply with Appendix C UCSC Post-Construction Requirements

CONSTRUCTION GENERAL PERMIT

A. Comply with the requirements found in the most recently adopted "State Water Resources Control Board, National Pollutant Discharge Elimination System (NPDES) General Permit for Waste Discharge Requirements (WDRs) For Storm Water Discharges Associated with Construction and Land Disturbing Activities (CGP)". Refer to Division 1 Section 01 57 23.

STORM WATER QUALITY

A. Site design shall effectively reduce runoff and pollutants associated with runoff from development and pollutant-generating sources.
B. Loading docks shall be designed to minimize run-on and runoff of stormwater. Direct connections from depressed loading docks (truck wells) to storm drains are prohibited. Refer to Campus Design Guide Standard Details.
C. All stormwater from loading dock areas must be treated by either a pre-engineered oil/water/sediment separator or pass through an oil/water/sediment catch basin and be capable of holding a minimum of 50 gallons.
D. For all hose bib connections, provide a quick-coupler, or, if attached to a building, a restricted access hose bib to prevent illicit discharge to the storm drain system.
E. Dumpster areas shall be designed with stormwater run-on and run-off diversion.
F. Screen all new dumpster locations either by wood fencing, concrete walls, or similar to prevent windblown trash. Container lids required.
G. If an outdoor sanitary sewer connection is provided for wash down, the area must be covered to prevent stormwater from entering the sanitary sewer and bermed to prevent run-on and run-off.
H. Food facility outdoor wash areas for cleaning equipment and accessories must be connected to an oil and grease interceptor before discharge into the sanitary sewer.
I. Provide drain to landscape in the bottom of utility boxes and vaults. Discharged water shall not enter a storm drain.
J. Fire sprinkler inspector test must flow to the sanitary sewer.
K. All interior floor drains must drain to the sanitary sewer.
L. Elevator sumps may not discharge to the storm drain system or daylight.
M. Outdoor materials storage areas shall be designed to prevent stormwater contamination from loose, particulate, or dissolved materials. Design features may include covering or enclosing storage areas and preventing run-on and run-off through the use of berms or grading design.
N. Do not use copper in any above-ground location where it may come in contact with rainwater or stormwater.

DESIGN REQUIREMENTS – STORMWATER FACILITIES

GENERAL

A. The storm drainage system shall be properly coordinated with surrounding campus terrain and improvements to ensure that run-off does not cause damage to adjoining areas.
B. Provide positive surface drainage away from buildings, a minimum slope of 2% (where feasible), to a collector, landscaped area, or disbursement system. A water test is required to check for positive drainage. Water may not drain across walks and paths. The design and location of any disbursement system are to be proposed by the Civil Engineer of Record for review and approval by the University in consultation with the Geotechnical Engineer.
C. Water storage, whether it be above ground or below ground, for retention or detention purposes, will only be deemed acceptable when required for stormwater management or non-potable use; the location of any such facility must be reviewed and approved by the University based on the recommendation of the geotechnical engineer. The geotechnical engineer shall include any water storage facility in the project geotechnical investigation including borings at or reasonably close to the storage location.
D. Size piping and all related stormwater facilities to accommodate a 10-year storm event at a minimum.
    1. Minimum Pipe Size is 8”.
    2. With the approval of the , an exception to use a 6” pipe may be allowed when it is technically infeasible to use an 8” pipe.
    3. Design gravity pipes to flow 90% full, without surcharge.
E. Drainage Structures shall include facilities such as Inlets, Catch Basins, Junction Boxes, Cleanouts, Manholes, Water Treatment Units, Flow Dissipaters, Area Drains, Bioretention, Bioswales, Vaults, and similar. Drainage structures shall be hydraulically designed to admit design quantities and shall be located to minimize visual impact, preferably below grade.
    1. Drainage Structure Locations: Structures shall be located:
        a. at a maximum spacing of 300 feet along any piped storm drain system
        b. at each change in either horizontal or vertical direction of pipe
        c. at each connection where two or more pipes join
        d. at locations where the drain changes size
    2. Drainage structures other than area drains are to be a minimum of 24" wide to allow cleanout and width must be equal or greater than depth, unless approved otherwise.
    3. Manholes shall be constructed with eccentric cones and shall have permanent ladders.
    4. Drainage Structures shall be designed such that the angle in the horizontal plain between the downstream and any incoming sewer is a minimum of 90 degrees.
    5. Provide ADA-compliant grates in walking areas. Provide traffic-rated grates at vehicle-accessible locations and heavy-duty forklift-rated grates in loading dock areas.
    6. All new storm drain inlets and catch basins are to be labeled to indicate the prohibition of illegal discharge. Coordinate with University Representative. Additionally, coordinate with the University Representative to determine whether any existing storm drain inlets residing within the Project Limits receive labels as part of the Project. In locations where new concrete catch basins are to be installed, a concrete stamp shall be used. Based on the location of existing storm drains, the label shall be one of the following: stencil, medallion, or sticker.
F. To the extent feasible, maintain the following minimum grades:
    1. For piped storm drain, 2.0%
    2. For surface drainage
        a. 1.5% for paved gutters and small paved ditches,
        b. 2.5% for small unlined ditches,
        c. 2% for area drainage of paved surfaces, and
        d. 2.5% for area drainage of unpaved yard areas.
G. The natural gradients of the existing terrain shall be retained with a minimum of cutting required. Cut and fill slopes shall not exceed 2:1 unless it can be demonstrated that a steeper slope will not result in increased erosion.

Storm Drain Pipe & Fitting Materials

1. Acceptable Pipe & Fitting Materials:
    a. PLASTIC
        i. SDR 26 PVC Gravity Sewer Pipe and Drain Fittings.
        ii. HDPE or PVC Pipe conforming to Section 64 of the Caltrans Standard Specifications, Type S (corrugated exterior and smooth wall interior) with positive, watertight joints per Caltrans Section 61-2.01D(2)(a) with the exception of no field testing required unless the manufacturer cannot demonstrate compliance via certified test results.
    b. Reinforced Concrete Pipe conforming to the requirements of Section 65 of Caltrans Standard Specifications. Joints shall be watertight per Section 61- 2.01D(2)(a), note that no field testing is required unless the manufacturer cannot demonstrate compliance via certified test results.
    c. Corrugated Metal Pipe conforming to the requirements of Caltrans Standard Specifications Section 66, all joints to be watertight.
        i. CMP is acceptable but not desirable, review the application with the University Representative and UCSC Engineering Services.
    d. Stainless steel hardware shall be provided.
    e. If there is an elevated hazard due to karst, confer with the University Representative and UCSC Engineering Services for appropriate below-grade piping material.
2. Pipe & Fitting Materials Not allowed:
    a. SDR 35 PVC
    b. Vitrified Clay
    c. Asbestos Cement
    d. Unshielded Couplings

Slopes through Drainage Structures (where applicable)

1. When storm drain conveyances of uniform slope pass through a manhole or other drainage structure, the slope shall be maintained and the invert at the center of the manhole shall be given on the plans.
2. When storm drains change slope at a structure, incoming and outgoing invert elevations shall be given.
3. Provide sufficient drop through a structure to compensate for energy loss caused by the change of alignment. A minimum drop of 0.1 foot is required for a change of alignment greater than 30 degrees. Maximum 90 degrees allowed.
4. When pipe sizes change at structures, design the inlet crown at least as high as the outlet crown.

Connection to Existing Campus Storm Drain Conveyances

1. Connect new mains to existing mains at existing structures or by constructing a new structure over the point of connection.
2. Where an existing storm drain conveyance is to be extended, remove the existing plug, cleanout, or rodding inlet, and install a structure. The main may be extended without installation of a structure only if it is on the same line and grade, the pipe size and material are the same and the structure spacing is adequate.
3. Elevations of mains connecting to existing storm drain conveyance mains shall be as follows:
    a. Side sewer mains connecting to an ex main at an angle of 30 degrees or greater shall be at least 0.1 foot higher than the existing.
    b. Connect sewer mains so that the crown of the smaller main is no lower than the crown of the larger main.
4. Where labeling of steel lids is feasible and typically done (i.e. can be considered "industry

standard," for example, on manholes), all lids shall be clearly marked, "**STORM**." In order to identify the foundry and ensure the frame and lid are a matched set, the manufacturer information may be included on the lid in substantially smaller text size when compared to STORM. Submit shop drawings of all items which include visible text (such as manhole lids)

CAMPUS NATURAL GAS DISTRIBUTION SYSTEM 33 51 00

Refer to Natural Gas Master Plan Project 11409-002G.

SYSTEM OVERVIEW

UCSC owns and maintains the underground natural gas distribution systems throughout the campus. There are two different pressure systems. The Campus Gas Distribution pressure is 10 PSI and monitored at a 2" riser on the south elevation of the Fackler Cogeneration Building. The campus also has a 45 PSI distribution system for use by the Co-Generation plant only. The existing campus gas distribution system is coated steel piping protected from electrolysis by a low-voltage cathodic protection system. Except for minimal quantities required to make connections to existing steel gas mains, no further additions of steel pipe will be made to the system so as not to stress the existing cathodic protection system. All additions to the existing system shall be with AGA-approved fusion welded polyethylene gas piping (Phillips Drisco Pipe, Nypac, or equal) Any breaks in the existing steel piping shall be bridged to maintain cathodic protection.

SYSTEM EXTENSION

A. Gas Systems shall be designed in accordance with Pacific Gas And Electric Company's Electric and Gas Service Requirements (Greenbook), latest edition at www.pge.com/greenbook.
B. As a precaution against damage from future trenching, all underground gas piping shall be installed at a minimum depth of 30 inches. Underground gas piping installations shall include a sand backfill, tracer wire, and detectable warning tape as called out in UCSC Campus Design Guide Standard Detail Typical Underground Pipe.
C. Extensions shall be connected to the 10 PSI Campus Gas Distribution only. If new gas demands are of significant magnitude such that the 10 PSI Campus Gas Distribution is insufficient, the Design Professional shall request approval from the University Representative for connecting to the 45 psi gas system. New services connected to the 45 PSI gas system shall be installed with a double regulator station.
D. Extensions to the system shall be full pipe size of the point of connection out to the project site at a minimum and looped back to the system in another location if feasible. Where the new extension is looped, the new piping shall be the larger of the two points of connection to the system.

NEW SERVICE CONNECTION (TO WITHIN 5' OF BUILDING GAS METER)

A. Gas Systems shall be designed in accordance with the Uniform Fire Code with California Amendments and NFPA.
B. Provide a gas regulator:
    1. Provide 7" w.c. or higher pressure depending on the equipment needs.
    2. Minimum 125 psi rated.
    3. Under pressure protection and over pressure protection.
    4. Pipe pressure regulation valve vent full-size per code.

C. Meter at each new building (See Division 22 16 00 for above-grade piping requirements and Division 33 05 33 for gas meter requirements). Rated to 25 psi minimum.
D. For new buildings to be connected to the campus natural gas system, the anticipated additional gas demand shall be identified early during preliminary planning. This anticipated gas demand shall be submitted to UCSC's Engineering Services. Improvements to the campus system may be required to accommodate the additional demand. The design drawings shall identify a suitable point of connection to the campus system and what system improvements may be necessary to accommodate the new building. The single line drawings must indicate total CFH and branch size's CFH.
E. Each new building service shall have a seismically activated earthquake shutoff valve.
F. New service for standby and emergency generators shall be independently regulated, metered, and NOT have a seismically activated shutoff valve.
G. Qualifications - The Contractor shall be manufacturer-certified for performing fusion splices of polyethylene gas piping.

MATERIALS

A. As a precaution against damage from future trenching, all underground gas piping shall be installed at a minimum depth of 30 inches. Underground gas piping installations shall include a sand backfill, tracer wire, and detectable warning tape as called out in UCSC Campus Design Guide Standard Detail, Typical Underground Pipe.
B. Where underground steel pipe is required to be used for connecting into existing steel mains, all joints shall be welded, except at valves, which shall be flanged. Where not factory coated, steel pipe shall be primed and wrapped with 2 overlapping layers of 10 mil tape.
C. Provide underground gas sectionalizing valves at all underground branch connections. Valves shall be steel body, lubricated plug type with a minimum working pressure equal to 200 P.S.I. (Homestead, Nordstrom or equal). Valves shall have a 2" square operating nut and extensions shall be provided as required to bring the operating nut and grease fitting within 6" of the top of the valve box. Valves shall be lubricated before they are put into service. (Install per UCSC standard Gas Branch Main and Valve Installation detail).
D. Provide each valve with a valve box and extension to the final grade. Valve boxes shall be pre-cast concrete with a triangular cast iron traffic cover marked "GAS" and painted red. (Old Castle G04 or equal).
E. Provide AGA-approved factory-fabricated transition riser between below-grade polyethylene piping and above-grade steel piping. (Wayne Manufacturing Anodeless Riser, or equal). Field-fabricated risers of wrapped or coated steel pipe are prohibited.
F. Meters must be provided for gas services. Reference section 33 05 33, Utility Metering Standards for BMS integration of pulse output.
G. Above grade piping to be painted safety yellow. Deviation must be approved by the Campus Architect.
H. Unmetered services is prohibited.

MINIMUM DESIGN REQUIREMENTS

The natural gas distribution system shall be designed per UCSC Campus Design Guide and the PG&E Greenbook for Natural Gas unless indicated otherwise henceforth.

METERING

References:

Division 22 00 00 Plumbing, Division 33 05 33 Utilities Meters, Division 27 Communications. Refer to the

Campus Standard Specification Section 33 51 00 Campus Natural Gas Distribution System. Reference Campus Design Guide Standard Details.

The natural gas meter shall be installed at a service connection to the building in an accessible location. The meter shall be capable of local and remote read-out.

PIPING

Pipe

1. Above Grade: Galvanized Schedule 40 primed and finish-painted epoxy coat. Epoxy paint to be Rustoleum 9100 System DTM Epoxy Mastic, or equal. Paint color to be Safety Yellow. Confirm color with University Representative.
2. Below Grade: MDPE with anodeless risers to above grade.

Fittings

1. Below Grade: Steel butt-welding or socket welding type
2. Above Grade:
    a. 2″ or smaller: malleable iron threaded.
    b. 2 ½″ or larger: Welded.

Valves

1. Below Grade: All valves shall be minimum one inch and flanged. No threaded fittings below grade.
2. Lubricated plug cock: 1 inch and larger, Homestead, Nordstrom, or equal. Refer to Campus Design Guide Standard Detail.
3. Corporation stops are prohibited.

Unions

1. Below grade: Unions are prohibited.
2. Above grade:
    a. 2″ or smaller: threaded metal-to-metal ground joint shall be used. Dielectric unions with rubber gaskets are prohibited.
    b. 2 ½″ or larger: Flanged.

Corrosion Control

In order to provide protection of above grade metal pipe from external, internal and atmospheric corrosion, provide an external protective coating and a cathodic protection system designed to protect the pipeline in its entirety.

Field Wrapping with cold-applied tape

a. Field joints shall use "Protectowrap" #200 with 1170 primer or equal. When coating odd shapes containing bolts, voids, or hard-to-wrap surfaces, two coats of mastic-type primer shall be used instead of the above primer, with special care to ensure that all surfaces are coated without introducing voids or pockets.
b. The bare metal surface to be wrapped shall be dry and cleaned of rust, dirt, oil, and weld slag. c. Whenever tape wrap is applied over yard wrap, the outer coating of Kraft paper, whitewash, mica, flakes, protective plastic outer wrap, etc., shall be removed.
c. Plastic-coated pipe, prime area to be wrapped plus a minimum length of 4 inches from the cutback edge.

    d. Tape shall be applied by first lapping over approximately one tape width of the prepared end of the wrap. The wrap shall be spiraled along the line, with each spiral overlapping the previous spiral by one-half the tape width plus one-quarter inch, to ensure a double thickness at all points. The tape shall be applied with enough tension to achieve a tightly bonded smooth wrap, free of wrinkles or voids. Do not over-stretch.
2. Asphalt Coating - Small defects (less than 3 inches across) - slight damage where the asphalt wrap is still bonded to the pipe and no penetration has occurred may be repaired by a single patch. Prepare the surface of the asphalt wrap by removing the outside coating with a wire brush, prime, and apply the single layer of tape so that it extends 2 inches beyond the damaged area in all directions. If penetration of the asphalt wrap has occurred or the bond has been broken, all loose wrapping shall be removed from the bare pipe. The area shall be primed and the standard spiral wrap applied. Large defects (greater than 3 inches across) - if the pipe coating is still bonded and penetration has not occurred, prepare the surface by removing the outside coating with a wire brush, prime, and wrap tape completely around the pipe, extending two inches beyond the damaged area on each side. If penetration of the coating has occurred or the bond has been broken, all loose or damaged coating shall be removed. Prime and apply the first layer of tape, patch fashion, the next layer uses the standard spiral wrap, extending 2 inches beyond the damaged area.
3. Plastic or Tape Coating - On plastic-coated pipe, repairs shall be treated as a large defect by tightly wrapping completely around the pipe as required. The entire plastic surface to be coated shall be cleaned. On tape-coated pipe, repairs shall be done by removing the outer wrap several inches back from the area of the defect, then prime and apply tape to the damaged area. It is not necessary to remove the inner wrap.

Inspection of Materials

Each length of pipe and each other component shall be visually inspected, inside and out, at the site to ensure it has not sustained any visual damage, and the pipe shall be inspected for holidays, using an approved holiday tester, immediately prior to installation in the trench. Coordinate test with the University’s Representative for witnessing. At least 48 hours' notice shall be given. Lacerations of the protective coating shall be carefully examined prior to the repair of the coating to see if the pipe surface has been damaged. All repairs, replacements, or changes shall be inspected before they are covered up.

Qualification of Welders - Only welders who are currently qualified in accordance with the following may perform welds on gas pipelines:

1. Section IX of the American Society of Mechanical Engineers Association (ASME) Boiler and Pressure Vessel Code.
2. Section 3 of American Petroleum Institute (API) Standard 1104
3. Appendix C of Federal Register, Vol. 35, No. 161.

Underground Clearance

Sufficient horizontal & vertical clearance shall be maintained between mains and other underground structures to:

1. Permit installation and operation of maintenance and emergency control devices such as leak clamps.
2. Permit installation of service laterals to both the mains and other underground structures. The intent is to avoid laterals ‘hopping’ over another main or structure.
3. Provide heat damage protection from other underground facilities such as steam or electric power lines. This is especially critical for cathodically protected pipelines, which shall be isolated from underground foreign piping.

PLASTIC PIPE

Polyethylene gas piping is the basis of design for all new underground installations. Steel piping is not allowed without approval from the Campus Engineer / Director of Engineering Services.

High-density polyethylene (HDPE) gas piping shall be used for all connections to the 45 PSI system and may be used for connections to the 10 PSI system. Medium-density polyethylene (MDPE) shall be used for connections to the 10 PSI system.

Service Lines (plastic)

1. 30-inch minimum of cover in streets and up to within 18″ of building's foundation footprint; 18-inch minimum of cover otherwise within 18″ of building's foundation footprint.
2. For metal pipe main connections serving a new plastic service lateral, provide full-size metal tee and three valve cluster. Transition to plastic service size downstream of isolation valve.
3. At the building wall the transition from plastic pipe to more rigid piping shall be facilitated with an anodeless riser and protected from shear and bending at the main connection. Where possible the trench bottom shall be compacted and smoothed, where not possible, some other method of continuous support for the service line shall be provided over the disturbed soil.
4. The service line shall be graded so as to drain any possible condensate into the main.
5. Each service line shall be installed so as to minimize anticipated piping strain and external loading.
6. Each service line shall have a service line valve.
7. Connection of new service line to existing live under service pressure plastic line by crimping existing service line is prohibited. Coordinate shutdown of existing gas service main for direct connections.
8. Tracer wire and warning tape shall be installed above all plastic piping per Campus Design Guide Standard Trenching Detail.
9. Service lateral to each meter: Extend tracer wire to above grade at anodeless riser serving a meter. Terminate a 24″ length of tracer wire with a 6″ loop diameter pigtail zip tied to the riser.

Inspection

1. Plastic pipe and tubing shall be carefully inspected for cuts, scratches, gouges, and other imperfections before installation.
2. Each imperfection or damage that would impair the serviceability of plastic pipe shall be removed or replaced with a new pipe section and fusible couplings. Stab fittings are not allowed.
3. The new pipe section and couplings shall be the same type and grade and wall thickness and shall be at least equal to that of the pipe.
4. Each plastic pipe joint shall be made in accordance with the manufacturer's recommendations using the proper type of equipment required for the type of joint. Plastic pipe may not be joined by a threaded joint or miter joint.

Installation of Pipe in Utility Trenches.

1. For mains and service laterals, a minimum depth of cover of 30 inches is required.
2. Piping shall be installed with sufficient clearance or shall be insulated from any source of heat, such as steam or electric power lines, particularly when installed in common trenches.
3. Inspect the condition of the ditch bottom just before the pipe is lowered in.
4. Plastic pipe shall be laid on a sand bed. See Campus Design Guide Standard Detail. Blocking shall not be used to support the pipe.
5. Piping shall be installed with sufficient slack to provide for possible contraction.

6. Piping shall be installed with enough clearance to allow proper maintenance and to protect against damage that might result from proximity to other structures.
7. Bends shall be free of buckles, cracks, or other damage, and may not be deflected to a radius smaller than the minimum recommended by the manufacturer.

Valve installation

Design to protect the plastic material against excessive torsion or shearing load when the valve is operated and from any other secondary stresses that might be exerted through the valve or its enclosure. Prevent excessive strains at valve installations by:

1. Use a valve having low operating torque.
2. Anchor the valve body to resist twisting.
3. Make the transition from plastic to metal some distance from the valve. Any transition shall be supported by undisturbed or well-compacted soil, by bridging, or by sleeve encasement. Transition pieces 2 feet long will usually provide sufficient stabilization.

Cathodic Protection of Isolated Steel Components in Plastic Piping Systems

Provide one of the following (confer with the University Representative and the UCSC Physical Plant Plumbing Shop prior to design):

1. A small galvanic anode directly connected to the steel component
2. Each steel component may be connected to a cathodic bonding wire which is also connected to one or more galvanic anodes. To facilitate monitoring, the cathodic bonding wire must be terminated at one or more test stations.
3. Use of certain metal fittings in plastic pipelines without coating, cathodic protection, and monitoring when adequate external corrosion control is provided by alloy.
4. Type 316 stainless steel or equally corrosion-resistant component.

Valve enclosures

Where curb boxes or other enclosures are used, they shall not be supported by the plastic pipe and shall not in any way impose secondary stresses. Valve operating stems shall be extended as per the University's Standard Drawing - Gas Valve and Valve Box. See Campus Design Guide Standard Details.

TESTING (steel and plastic):

All underground piping shall be pressure tested at a minimum of 100 psi, for a minimum time of 4 hours. Soap test final joint at line service pressure. Testing against existing campus valves is prohibited. The pipe to be tested will be physically separated from existing systems and connected after passing inspection. Physical Plant must be present to witness and verify with a combustible gas indicator to ensure no leaks are present.

CAMPUS DISTRICT COOLING WATER SYSTEM 33 62 00

Refer to Cooling Water Master Plan Project 11409-002B

The central campus has a tower cooling water system providing cooling water for chiller and lab waste cooling water heat rejection. The system consists of supply and return lines. Provide pipe and fittings per the requirements for water mains included in Section 33 11 00 Campus Water Utility Distribution.

Valves - Class 250B butterfly valves, Mueller Lineseal XP Class 250, or equal. Cooling water system butterfly valves shall be flanged and shall be of the rubber seat type. Valve discs shall rotate 90 degrees from the fully open position to the tightly shut position. The valve seat shall provide a tight shutoff at a pressure differential of 150 psi upstream and 0 psi downstream in either direction. The valve shall open with a counter-clockwise rotation, have a 2-inch operating nut for buried valves and hand wheel for open installations, and have o-ring seals. Buried valves shall be rated for buried service and epoxy coated inside and out. All hardware (i.e.: nuts, bolts, washers, etc.) buried below grade, and above grade at cooling towers, shall be 316 stainless steel.

Branch Connections - All connections to the cooling water distribution system shall use three valve tees per the requirements for water service lines greater than 2" as described in Section 33 11 00 Water Utility Distribution.

Tapping - When using tapping valves on the cooling water system, install an additional butterfly valve and abandon the tapping valve in place (in the open position). Reference section 33 11 00 for required tapping sleeve materials.

CAMPUS DISTRICT HEATING WATER SYSTEM 33 63 00

Refer to Heating Water Master Plan Project 11409-002H

GENERAL

This section contains design guidelines pertaining to new connections to the campus district heating water system including the primary/secondary pumping interface required for each building connection. Also included are guidelines for underground hot water piping between buildings.

RELATED GUIDELINES

A. See Section 22 00 00 for Plumbing Design Guidelines
B. See Section 23 00 00 for HVAC Piping
C. See Section 25 00 00 for Building Management System.

DEFINITIONS

A. Primary Heating Water: Primary heating water shall be defined as heating water supplied directly from the campus district heating water mains on the primary side of a building's primary/secondary pumping bridge or heat exchanger.
B. Secondary Heating Water: Secondary heating water shall be defined as heating water within a building on the secondary side of a primary/secondary pumping bridge or heat exchanger.

CAMPUS DISTRICT HEATING WATER SYSTEM

A. Background: The core academic buildings on campus are served by a district heating water system supplied by the Fackler Co-Generation Central Heat Plant. The system was originally designed by Kennedy Engineers and installed in several phases beginning in 1966. Initially, it was operated as a high-temperature system with the district supply water temperatures ranging up to 360 degrees Fahrenheit. In 1987 co-generation was added to the central heat plant and the system was converted to a low temperature system with supply water temperatures being kept below 250 degrees Fahrenheit. Drawings for the original system and subsequent retrofits are available from the campus archives.
B. Present Operation: The system is currently operated as a variable flow system. System differential pressure is controlled to a constant 8 PSI differential at DP Feedback in McHenry Library Basement Mechanical Room. Currently, the DP transmitter is located in the McHenry

Library Basement Outdoor Air Intake (there is also an alternative backup DP transmitter at Kerr Hall). The interface at each building is either a primary/secondary pumping bridge or a heat exchanger dependent on elevation relative to the Central Heat Plant. Flow through the primary system at each building is controlled by a 2 way control valve which is modulated to maintain the secondary supply water temperature between 165 and 180 degrees Fahrenheit. The primary heating water supply temperature is reset at the central plant based on multiple parameters up to a maximum temperature of 220 degrees Fahrenheit currently, with plans to convert to a lower temperature heating loop with temperatures of 145 degrees Fahrenheit primary supply temp.

C. New Campus Core Buildings: The district heating water system may be used as the primary heat source for space heating and hot water for all new buildings constructed in the campus core. Per the campus Decarbonization & Electrification plan, heat pumps may be the primary source of heat. Confirm primary heating source for specific new buildings with the University's Representative.
    1. Exceptions
        a. Domestic & industrial hot water may be heated with hot water heater(s) located at the building when the use is anticipated to be relatively low and when approved by the University's Representative. See Section 23 00 00 for water heater requirements.
        b. Space heating for small buildings with space heating loads of 500,000 BTUH or less may be accomplished with the primary heat source located at the building when approved by the University's Representative. See Section 23 00 00 for primary heat source requirements.
        c. Buildings that have sites remotely located (1,000 feet or more) from the district heating water mains may be accomplished with the primary heat source located at the building when approved by the University's Representative. See Section 23 00 00 for primary heat source requirements.

D. Adding Heating Load: For new buildings to be connected to the district heating system, the anticipated additional heating load shall be identified early during preliminary planning. This load shall be submitted to the University's Representative for review UCSC Engineering Services. Improvements to the district system may be required to accommodate the additional heating load.

E. District Heating System Design Requirements
    1. General Design Considerations
        a. Maximum Working Temperature and Pressure: All portions of the primary heating water system above and below grade shall be designed to accommodate a maximum temperature of 250 degrees Fahrenheit occurring at a pressure of 150 PSI. See section 23 00 00 for the building's secondary heating water systems.
        b. Water Protection: Below-grade piping, vaults, and manholes shall be designed to prevent the intrusion of water which could saturate the pipe insulation. Flooded manholes and vaults will conduct significant quantities of heat out of the system into the surrounding earth. The outer conduit of conduit piping systems shall be sealed watertight. Seal all penetrations of vaults, manholes, and concrete-lined trenches watertight. Provide a gravity drain at each vault and manhole and discharge to daylight.
    2. Air Relief:
        a. The layout of the underground piping system shall be carefully considered so as to minimize the number of system high points where air will be trapped. (Trapped air will decrease system capacity.)
        b. Provide manual air reliefs at all system high points. Air relief valves shall be accessible. Pipe air relief discharge to a safe location away from the operator. (Note: Steam flashing will occur under some operating conditions.) Air reliefs for the district heating system shall be detailed on the Working Drawings.

c. Wherever site grades allow, slope lateral piping to buildings at a constant slope so that air will migrate either to the district mains or to accessible locations inside the building.
d. Pipe reducers for horizontal pipe shall be eccentric type installed to provide a uniform top of the pipe.

3. Drain Down:
    a. Provide means for draining down lateral piping to buildings either at the building or adjacent to the isolation valves at the district mains depending on grade. All system low spots shall be provided with a valved drain leg equipped with a capped hose connection fitting.
4. Building Interface:
    a. Decoupler Bridges: The building interface for buildings with the lowest point of the heating system occurring at elevation 775 feet and higher (Thimann Laboratory basement and higher) shall be by primary/secondary pump bridge.
    b. Heat Exchangers: The building interface for buildings with the lowest point of the heating system occurring lower than elevation 775 feet (lower than Thimann Laboratory basement) shall be by plate and frame heat exchanger. The heat exchanger shall be rated for 300 psi primary and building secondary pressure.
    c. Color Coding: Primary heating water piping inside buildings shall be color-coded red and labeled for flow direction.
    d. For all control valves: Provide unions or flanges. Provide isolation valves where appropriate to allow for immediate replacement.
    e. 2-Way Control Valve: Provide a 2-way modulated automatic control valve on the primary heating water return piping at each building to control the flow of primary heating water. Provide DDC control of the valve from the campus central energy management system (see Section 25 00 00). Select the valve to be capable of full shut off against a differential pressure of 50 PSI. Call out the valve Cv on the drawings. For buildings with primary/secondary pumping, select the valve Cv to provide a 5 PSI pressure drop at the design flow rate. For buildings with a heat exchanger, select the valve Cv to provide a pressure drop equal to the pressure drop through the heat exchanger at design flow. Check with the Campus Sr. Mechanical Engineer for the design provision as it may have changed.
    f. Division 33 Design Engineer shall coordinate with Division 23 Facilities Engineer. Provide DDC sequence of operation to control secondary heating water supply to a set point of between 165 and 180 degrees (adjustable). Note that limiting the control valve stroke in the PID control loop program to a value less than 100% open can be implemented when operating experience shows that wide-open flow is so high that a given building "starves" other buildings of flow during high loads (morning warm up in cold weather). Primary hot water flowrate from the BTU meter can be used to initially set this stroke limit based on measured flow. For reference the Sequence of Operation shall be as follows:
        1. Whenever SHW pumps are operating, BMS to modulate control valve in PHWR to maintain Secondary Hot Water Supply (SHWS) temperature at setpoint. When SHW pumps are off the control valve shall be fully closed.
        2. An alarm shall be initiated whenever SHWS temperature is below 160 F (adj.) or above 190 F (adj.) for a period of 20 minutes (when HW pump is operating).
        3. SHWS temperature setpoint shall be as follows:
            a. SHWS setpoint = PHWS temp – 5 deg F (adj.) but,

b. SHWS setpoint shall never be less than 165 F min (adj.) and never be greater than 180 F max (adj.)

g. BTU Meter: Provide a BTU meter on the primary heating water loop at each building. Interface the BTU meter with the campus central energy management system and provide the following information: primary heating water flow rate, primary heating water supply temperature, primary heating water return temperature, and instantaneous energy use rate (BTU/Hr). Totaled energy use (BTU's). Refer to Division 33 05 33 for BTU meter requirements.

h. Balancing Valve: Provide a pressure-independent constant flow balancing valve with flow measuring capabilities as detailed to throttle the maximum primary heating water flow rate to a constant maximum flow rate under varying differential pressures. Balance the primary heating water flow to the design flow rate while verifying that the 2-way automatic control valve is fully open and that the pressure differential at the system mains is being controlled to a constant 20 PSI by the campus energy management system.

i. Expansion Tank:
    1. For buildings with primary/secondary pumping through a de-coupler bridge an expansion tank is not required.
    2. For buildings with primary/secondary pumping through a heat exchanger, select the heating water expansion tank to accommodate the possible pipe volume change of the secondary hot water system within the building.
    3. Oversize the building expansion tank to provide for a minimum future increase in system pipe volume of 20 percent.
    4. Dedicated isolation valve and test tee.
    5. Expansion tank shall be replaceable bladder type.

j. Makeup Water:
    1. For buildings with primary/secondary pumping through a de-coupler bridge, make-up water is not required for the building heating water system. Make-up water will be provided from the Central Heat Plant via the system mains.
    2. For buildings with primary/secondary pumping through heat exchangers, make-up water through a reduced pressure backflow preventer and pressure regulator with quick-fill by-pass, a T&P relief valve, a chemical pot feeder, and air elimination fitting will be required on the building side of the heat exchanger.

k. Water Treatment: For buildings with primary/secondary pumping through a decoupler bridge, a water treatment chemical pot feeder is not required for the building's heating water system. Chemical treatment will be provided from the Central Heat Plant via the system mains. Buildings with primary/secondary pumping through heat exchangers shall be provided with a chemical treatment pot feeder across the secondary pumps suction and discharge piping.

5. Primary Heating Water Pipe Sizing: Primary heating water piping shall be sized based on the following criteria:
    a. Size to accommodate the pressure drop through all primary loop components based on the design flow rate plus 50 percent. The design flow rate shall be based on the assumption of a minimum 40-degree Fahrenheit temperature differential between the primary heating water supply and return. Confirm available pressure differential with Engineering Services prior to design.
    b. In no case shall primary heating water piping be sized with a velocity greater than 6 feet per second based on the design flow rate plus 50 percent.
    c. The minimum size for primary heating water piping laterals from the system

mains to a building shall be 2-1/2 inches. Supply and return piping may be reduced in size once inside the building.

6. Connection to Existing District Heating Water Mains:
    a. The points of connection to the existing district heating water mains shall be verified with the University's Representative taking into account: the additional heating load to be imposed on the system, accessibility, and pipe anchoring considerations.
    b. Most of the existing heating water manholes were constructed with piping provisions to accommodate future building connections. Connection to the existing mains inside an existing manhole is usually the best option when available.
    c. Connections to existing heating water mains shall be detailed on the Working Drawings. The Design Professional shall be responsible for verifying the probable existing conditions at the intended points of connection by referring to the campus archive drawings and field-verifying accessible points of the system. Consult with the University's Representative in cases where as-built conditions are critical such as close proximity to the footing of a future building.
    d. New connections to the existing heating water mains shall be made by welded-in tee fittings. Penetration of the existing pipe wall shall be drilled, saw cut, or ground followed by reaming, so as to produce a smooth surface with minimal flow restriction. The use of cutting torches to penetrate the existing pipe walls is prohibited. The contract documents (Division 1) call out the coordination of the heating system drain down to allow for welding as an activity to be listed on the schedule. Drain-down duration shall be called out to be as short as possible and shall not occur in the heating season. System drain downs shall be coordinated with UCSC Physical Plant with a minimum of 14 days advance notice.
    e. Provide manual observable stem and yolk (OS&Y) isolation valves with a minimum operating pressure rating of 600 PSI at the points of connection of primary heating water laterals to buildings to the district heating water mains. Heating system valves shall not be buried. Provide a concrete vault at the valves with ample space for valve operation and removal of valves. Provide a gravity drain to keep the vault clear of water. Isolation valves shall be flanged, steel body, bronze trim with visual status indication.
    f. The existing mains throughout most of the campus are routed inside a poured-in-place concrete-lined trench with a continuous concrete lid. When making new connections at a point where the concrete trench occurs, (1) Provide for required concrete saw-cutting, (2) Provide for re-sealing of concrete trench to prevent water intrusion into the existing concrete lined trench.
    g. The existing mains throughout most of the campus are insulated with approximately 2" of asbestos-containing calcium silicate pipe lagging. Where this occurs, provide notification within the contract documents of the presence of asbestos and include asbestos abatement as a contract requirement. Coordinate this issue with the Executive Architect and the University's Representative.
    h. Connections to the existing mains shall be designed to accommodate the expansion of the system mains. For this reason, new connections shall be located adjacent to existing anchors for the system's pipe mains whenever possible. Where this is not practical, calculate the expected expansion of the main and provide a connection design that will accommodate the lateral movement. Connection at the center of an existing expansion loop is often the best alternative option.
    i. Lateral connections to the existing heating water mains shall be made taking into consideration the system point where air relief will occur. If the lateral pipe is connected to the top of the main, air relief will need to be provided to

accommodate both the lateral and system main. In some cases, it may be beneficial to specify the connections as occurring to the bottom or side of the main to avoid needing to install additional air reliefs.

j. Heating water piping shall not be routed under building slabs or footings.
k. When connecting to the main, the coupon from the drilled hole will be turned over to the University Representative.

7. Acceptable Piping Materials, Primary Heating Hot Water
    a. Below grade buried: Buried heating water pipe shall be a factory-manufactured conduit piping system. Inner carrier pipe shall be Schedule 40 black steel with butt welded fittings. Insulation between carrier and conduit pipe shall be 2-inch thick closed-cell polyurethane foam. Outer conduit pipe shall be either PVC or filament-wound polyester resin composite. The outer conduit system shall be sealed watertight. Outer conduit shall be continued through pipe penetrations of concrete walls with concentric space being sealed watertight by mechanical seals. Provide provisions to accommodate pipe expansion either by expansion loops or specially manufactured elbows. Provide an anchoring system where required to control the direction of pipe movement. Acceptable products include Ricwil Terra-Gard, Perma-Pipe PolyTherm, and equal products from other similar manufacturers. Install in accordance with manufacturer's directions and UCSC Campus Design Guide Standard Detail, Typical Underground Pipe.
    b. Above grade and exposed within vaults & manholes: Schedule 40 black steel pipe with butt welded fittings except valves and strainers shall be flanged. Piping and fittings to be fully insulated with 2-inch thick fiberglass. See section 23 00 00 for additional requirements for above-grade HVAC Piping.
8. Testing and Inspection:
    a. Primary heating water piping shall be hydrostatically tested at a minimum pressure of 400 PSI for a period not less than 4 hours. Provide slip blinds at valve flanges for valve protection during testing.
    b. For buried conduit system piping, the joints for the inner carrier pipe will be left exposed until all testing has been completed.
    c. For buried conduit system piping, the outer conduit shall be air-tested in accordance with the manufacturer's directions.
    d. For buried conduit system piping, all testing shall also be in accordance with the manufacturer's directions. Consult with the University Representative should the manufacturer's directions conflict with the above.

UNDERGROUND HOT WATER PIPING BETWEEN BUILDINGS

A. As a general rule for buildings not connected to the campus district heating water system, underground routing of piping for space heating or domestic hot water is not allowed. Primary heating sources shall be located in the buildings.
    1. Exception
        a. Small buildings with relatively small loads may have space heating and domestic hot water provided via underground hot water piping from adjacent buildings when approved by the University's Representative.
B. Acceptable Piping Materials, Hot Water Piping Between Buildings
    1. Below grade buried: Buried hot water pipe between buildings and not part of the campus district heating water system shall be a factory-manufactured conduit piping system. The inner carrier pipe shall be Type K copper tubing. Fittings shall be wrought copper with joints brazed with 15% silver brazing conforming to AWS classification BCuP-5. Insulation between carrier and conduit pipe shall be a minimum of 1-inch thick closed-cell polyurethane foam. The outer conduit pipe shall be PVC. Outer conduit shall be sealed watertight. Provide provisions to accommodate pipe expansion through the use

of expansion loops and elbows. Such systems shall not be placed under any concrete slabs and shall be recorded on as-built drawings. Provide a restraint system of thrust blocks and anchors as required for the specific application. Acceptable products include Ricwil Copper-Gard and equal products from Perma-Pipe or other similar manufacturers. Install in accordance with manufacturer's directions and UCSC standard detail, Typical Underground Pipe.

ELECTRICAL UTILITIES 33 70 00

ELECTRICAL UTILITY PLANNING

Overview of existing campus medium voltage system 21 kV to 12kV

UNIVERSITY 21kV SUBSTATION AND PRIMARY 12kV SUBSTATION
The University is currently served by PG&E at 21kV entering the campus at a substation near lower-south campus in grid 108 called 'Slug-Sub'. Two 21kV feeders are routed from this substation to Merrill Substation (SWBD M) where service is transformed to 12kV via two 8625 kVA transformers operating in parallel to a common bus and then distributed throughout campus on the four modified radial 12kV feeders, A1, A2, B1 and B2.
The campus also receives medium voltage power from a 2MW solar PV array and battery storage facility at the east remote parking lot. The feeder from this system runs down to the main 'Slug Sub' substation and feeds into the 21kV network via breaker 52-R.

UNIVERSITY 12kV SWITCH, SUBSTATIONS
Some switch stations are constructed with multiple circuit breakers and are capable of distributing power at 12kV to feeders and substations distributed throughout the campus. These substations provide a second level of protection to the main substations, enable selective coordination through high-speed protection relays, and reduce the areas of the campus that would be affected by a local outage. Some switch station protection consists of relays that can detect the following conditions: out-of-phase, overcurrent, phase-to-phase faults, and phase-to-ground faults. The substation can also isolate an area that would require maintenance or modification. The main 12kV Switch/Substation is at Merrill College and is denoted as SWBD M. SWBD M is divided into two feeder buses, SWBD A and SWBD B.

COGENERATION PLANT
The campus has a 4.6 megawatt combined cycle cogeneration facility connected to the 12kV distribution via Substation T (SWBD T) with breakers serving feeders A1, A2 and B1. The plant is built around the Solar Mercury Recuperated Combustion Turbine package. The cogen is tied to the utility via individual feeders that are connected via circuit breakers. When utility is lost, a load shed scheme opens non-critical feeders (A2 & B1) and keeps the A1 feeder energized. The cogen was designed to carry the A1 feeder in island mode if the utility was lost for an extended period of time when it was installed.

Design Notes: There are no spare breakers at Slug-Sub or SWBD M. SWBD T is designed with a breaker that has been designated as a future Fuel Cell. In addition, there is a spare breaker in SWBD T that is intended to connect to the B2 feeder at a future date. If new feeders are proposed, the lineups would need to be expanded and new sections required. In this case testing, commissioning, integration, and relay settings to a new fault current and coordination study would be required. All campus 21kV and 12kV cabling shall be designed per this Campus Design Guide. Where there are references to 12kV versus 12.47kV, the campus considers this a nominal 12kV system. There is no voltage regulation on the system and PG&E maintains voltage regulation at the Slug Substation service point in accordance with Electric Rule 2.

DISTRIBUTION SYSTEMS PROTECTIVE RELAYING

This information is provided to give the Design Professional an idea of the utility nature of the campus 12 kV distribution grid. Generally, any improvements at Slug-Sub, SWBD M, and SWBD T would require the removal of, and or integration into the existing scheme. The ability to integrate this information and communicate it to the protection devices as well as to the users is centered on a processor that is designed to know the status of all the protection relays. The protection relays are designed to have layers where instruments with very specific design properties overlap and back each other up. (i.e. permissive overreach transfer trip 'POTT' schemes). The following are some of the existing relays currently in service on campus.

1. SCHWEITZER SEL 2032 communication processor
2. SCHWEITZER SEL 2100
3. SCHWIETZER SEL 2401
4. SCHWIETZER SEL 3401
5. SCHWEITZER SEL 3530 RTAC
6. SCHWEITZER SEL 311
7. SCHWEITZER SEL 351
8. SCHWEITZER SEL 751
9. SCHWEITZER SEL 700G

POTENTIAL AND CURRENT TRANSFORMERS
The aforementioned instruments and others associated with circuit switches, transformers, and circuit breakers require the use of specialized instrument transformers. These devices are attached directly to the live line as potential transformers or around the line as current transformers. These transformers reduce the voltage and current to a safe usable amount. These are precision instruments and their accuracy provides the instruments with data that allows the protection relays to respond in 2-5 cycles, (0.033 to 0.083 seconds). Building level metering and the use of Potential and Current Transformers in building switchgear shall be coordinated between the supplier of the switchboards and the Utility Metering Standards in UCSC Design Guide Division 26 27 13 and Division 33 05 33. Selection of PT/CT ratios (typically 600:5) and use of correct ANSI class devices are critical to accuracy and the Design Professional shall coordinate design tolerances with the University Representative.

BULK, LOOP, AND RADIAL FEEDERS
The object for efficiently delivering electricity to the final users is one where electricity is received as high a voltage as available thereby reducing the size of wire required to transport it. When the voltage is reduced the ampacity and wire required to carry the same load is increased. The switch/substations provide this point of distribution through the use of interrupters, switches, and medium voltage cables. The campus has a range of feeder sizes depending on the location and the Design Professional shall confirm the feeder size at the point of connection to the existing equipment with the University Representative prior to any design activities. The design objective will be to provide a consistent feeder size so as not to limit capacity without overbuilding services that feed a single load. Verify with the University Representative if the feeder will serve a LOOP feature to enable selective isolation and back-feed onto sections of the grid.

There are three methods by which these cables are run:

1. BULK FEEDERS are the 21kV feeders that connect Slug-Sub to SWBD M where these feeders terminate on isolation switches. There are two bulk feeders operating in parallel. The cable size of a bulk feeder is one set of three 250 kcmil copper conductors in an existing 4-inch conduit.

2. RADIAL FEEDERS are duct banks that are dedicated to one interrupter and one transformer or a group of transformers with no backup feeder or return to the point of distribution. Generally, feeder sizes on campus are 4/0 with some installation of #1, #2, and 3/0. Design Professional shall verify feeder sizes with the University Representative.

3. LOOP FEEDERS are applied on campus where it is determined the rating of conductors and equipment will permit back-feed of a feeder through the line side of switches. This method utilizes switches, interrupters, and transformers. Medium Voltage transformers have two feeders with make-before-break load interrupter switches. This equipment allows the transformer to connect 2 sets of different cables at once. The cables can be switched straight through to another transformer or isolate a feeder for backup that can be switched on for emergency or maintenance. It is critical to confirm ratings of separable connectors and the Design Professional shall coordinate with the University Representative on application of Loop Feeders. It is critical that any two feeders that have the potential to be looped are phase synchronized.

Distribution System Extensions:

In general, the distribution system is set up as a modified radial feed with 4 primary feeders on campus named A1, B1, A2, and B2. Generally, each feeder is distributed to a discrete area of campus. The A1 feeder is defined as the critical feeder and in the event of a utility power failure, the campus Cogen Facility is set up to island the A1 feeder. The A1 feeder primarily serves research buildings on Science Hill. In addition to the 12kV system, there are areas on the lower and west sides of campus that are not on the campus 12kv grid.

A limiting factor in the design of 12kV infrastructure is the sizing of building transformers. Calculated demands in larger facilities can result in transformers that will not coordinate with the distribution system's overcurrent protection scheme and careful consideration of distribution system settings is required to retain selective coordination on the system. The design professional may request from the University Representative that UCSC Engineering Services provide the trip curves for the feeder breakers that protect the feeders if such trip curves are available. If the trip curves are NOT available, it shall be the Design Electrical Engineer's responsibility to come on to campus and perform whatever surveying, investigation, or interrogation of relays necessary to obtain the trip curves. The Design Electrical Engineer shall design the system to enable selective coordination for IEEE device numbers 50/51 and 50/51N and confirm requirements with the University Representative. This generally means 12 kV transformers with smaller than 80E (80Amp) fuses will coordinate, anything larger may require relay-equipped pad-mount sectionalizing switches, or unit substations to enable coordination with the campus utility feeders. All local switches are protected by fuses.

When constructing a building, work generally consists of extending (2) of the main feeders from the core infrastructure to a building site via pad-mounted sectionalizing switches that are installed on the distribution system. Given the master planning that has been conducted on campus, and the recommendations of an additional 21kV service, feeder extensions shall consider campus loading at the time of the development, and the potential for the second 21kV service. This consideration could result in an extension of 21 kV feeders which changes the ratings of the component parts in the project from 12 kV to 21 kV. The Design Professional shall confirm which feeders, and what voltage to extend with the University Representative.

At a building site, unit substations are preferred that are provided with either fused load interrupters or circuit breakers to coordinate with the campus utility feeders.

The two feeders extended to the unit substation are designated primary and alternate for new or renovated facilities.

Since the primary and alternate feeders are from the same utility source, kirk-key interlocks are generally not required, this enables the campus to switch between primary and alternate feeders without disrupting service to a building or building complex. The Design Professional shall confirm with the University Representative the requirements for kirk-key interlocks and phasing requirements, so system commissioning can be developed for this part of the work.

Designers are to verify the points of connection to the utility system with the University's Representative and once the point of connection is identified design parameters such as short circuit currents, and symmetrical components are provided to the designer for use in developing the design. If the work requires coordination with PG&E the Design Professional will verify procedures and protocol for communicating with PG&E.

If the project is such that a complex of buildings will be served by a single 12kV substation the substation can have multiple transformers, one for each building, and in this case the feeders extended from the distribution system to the site will have additional multi-way pad mounted switches or circuit breakers, depending on the size, to feed individual transformers, i.e. no unit substations.

In selecting multi-way switches the Design Professional shall consult with the University Representative to ascertain if the use of sectionalizing and building multi-way switches will be used in a looping function that will enable the campus to back-feed segments of the distribution system. This will determine if 200-amp or 600-amp separable connectors will be used on these pad mount switches. Coordinate with the University Representative for details specific to the project.

POWER SYSTEM STUDY 33 71 00

Conform to the following guidelines:

1. Perform Short Circuit, Protective Device Evaluation, and Protective Device Coordination Studies. The study shall be prepared and signed by a California-registered Electrical Engineer. Submit studies to the University's Representative prior to receiving final acceptance of distribution equipment shop drawings or prior to release of equipment for manufacture. If formal completion of studies may cause delay in equipment manufacture, acceptance from the University's Representative may be obtained for preliminary submittal of sufficient study data to ensure that the selection of device ratings and characteristics shall be satisfactory. Provide for both normal and emergency systems.
2. Studies shall include all portions of the electrical distribution system from the point of connection to the medium voltage feeder network to the primary section of service transformers down to and including the 480V and 208V distribution system panelboards. Normal system connections and those which result in maximum fault conditions shall be adequately covered in the study.
3. The study report shall summarize the results in a final report. The following sections shall be included in the report:
   a. Description, purpose, basis, and scope of study and single line diagram of that portion of power system which is included within the scope of the study.
   b. Tabulations of the circuit breaker, fuse, and other protective device ratings versus calculated short circuit duties and commentary regarding same.
   c. Protective device time versus current coordination curves, tabulations or relay and circuit breaker trip settings, fuse selection, and commentary regarding same.
   d. Fault current calculations including a definition of terms and guide for interpretation of computer printout.
   e. Device identifications referenced on power systems study printouts and single-line diagrams shall coordinate and agree with device identifiers on contract documents.
   f. Company name performing study.

g. The Electrical Engineer responsible for the study.

h. The date study was performed.

4. Protective Device Testing, Calibration, and Adjustment: The Design Professional shall stipulate the Contractor is to provide the services of a NETA certified third-party testing agency and to provide necessary tools and equipment to test, calibrate, and adjust the protective relays and circuit breaker trip devices as recommended in the power system study and in accordance with published NETA testing standards.

ELECTRICAL UTILITY POLES 33 71 16

The campus guidance is to avoid permanent overhead electrical service and utility poles. The following is general guidance for temporary overhead service as well as any proposed permanent overhead service. The Design Professional shall coordinate with the applicable discipline regarding subsurface conditions relative to the pole foundations. For temporary utilities coordinate with Division 01 51 00 Temporary Utilities.

Conform to the following guidelines:

1. All overhead 12kV main distribution wire shall be 336.4 MCM AAC.
2. All overhead bulk or trunk lines rated for loads above 200 amps but below 400 amps shall be 336.4 MCM AAC wire.
3. All pole top construction shall be tri-mount with kingpin, per PG&E standards.
4. All guy wires shall use insulating rods (fiberglass, with clevis and tongue ends). Guy insulators shall be porcelain.
4. All overhead lines shall be 3-phase, 3-wire.
5. Inline hook stick isolating load break switches shall be installed where practical to aid in isolating sections for repair. See Section 33 77 00 Medium Voltage Utility Switchgear and Protection Devices.
6. All cross arms and brackets shall be of steel or fiberglass construction.
7. All Potheads on risers shall be porcelain.
8. All cable terminations in cabinets shall be cold shrink with skirts (no rollovers).
9. Overhead lines shall have fault indicators installed at a convenient location to facilitate fault location.
10. Surge arresters shall be used on trunk or backbone feeders during the transition from overhead to underground. A lightning arrester shall be installed on the riser when deemed necessary.

ELECTRICAL UNDERGROUND DUCTS AND MANHOLES 33 71 19

Electrical Duct - All 12kV electrical power ducts shall be constructed with concrete encasement and with a minimum 30-inch cover to the top of the concrete. Concrete encased raceway shall be PVC schedule 40 duct and end bells. Elbows shall be factory-made, using a minimum radius of 48 inches. Provide GRC elbows on runs greater than 100 feet or on runs with more than two 90-degree elbows. Install 3" minimum concrete encasement on duct banks. Multiple runs shall maintain a 3-inch minimum separation between runs. Provide plastic spacers at a maximum of 5 feet-0 inch centers to maintain 3-inch spacing between conduits. Drive two reinforcing bars to anchor the conduits at 10 feet-0 inch centers to prevent floating during concrete pour. Specify color mix as 10 lbs of red oxide per yard of concrete. All ducts shall drain to a manhole or pull box. New infrastructure shall be 5” conduits for 12kV and 6” conduits for 21kV. In cases where 480 V distribution occurs within a complex, the 480 feeders shall be concrete encased similar to the 12kV system.

ELECTRICAL MANHOLES

Manholes shall be sized to accommodate all feeders, wiring, switching, and extensions to future buildings. Manholes shall be reinforced concrete, cast in place, or precast and designed for H2044 wheel loading. Provide knockouts for future duct connections.

Electrical manholes shall be an octagon design. The minimum inside clear width shall be 8 feet 0 inches, minimum inside clear height 8 feet 0 inches. Locate sumps in manholes where water can collect and connect the manhole sump to a gravity drain to daylight if practical. Where not practical provide the manhole with a powered sump pump located in an unused corner. For manholes without a powered sump pump, locate sumps in the center. Sumps shall not discharge to the storm drain system.

Pulling irons shall be installed on the wall opposite of each duct line entrance. The spacing of manhole steps or ladder rungs shall not exceed 16 inches. Manholes with equipment shall be equipped with convenience receptacles for equipment and appropriate switching and lighting.

Manhole Cover - Manholes shall include manhole covers stamped/cast with "ELECTRICAL" on the top of the cover. Manhole covers shall be two-piece, covered with a 48-inch outer ring and a 24-inch inner ring complete with two 2-inch openings for manhole hook accessibility. Manhole lids shall identify the full manhole “MHE-“ ID code assigned to the manhole by UCSC with a permanent welded or engraved text.

Medium Voltage Pull Box - The minimum size of pull boxes shall be 4 feet by 6 feet by 3 feet, precast reinforced concrete. Pull boxes shall be rated for HS 20-44 wheel loading and stamped/cast with "ELECTRICAL" on the top of the cover. Pull box covers shall identify the full pull box “EPB-“ ID code assigned to the pull box by UCSC with a permanent welded, engraved, or bolted-on label. Provide drain to daylight.

MANHOLE AUXILIARY POWER SYSTEM

Design Professional shall coordinate power to manholes with the University Representative to provide adequate 120-volt single-phase power in each of the Manholes for service to lighting, convenience power, and sump pumps. Circuits shall be protected by GFCI devices.
The entire system in the Manholes shall be watertight, submersible in each Manhole, from 6 inches below the Manhole ceiling to the bottom of the Manhole.

Where used, the Cable Bus shall be 480 V, 2 wire, from the connection to the existing system, common to a load transformer in each of the Manholes. A Multi-Conductor Cable, 3 conductor No. 6 AWG stranded copper conductors, sheathed. Cable type USE, with two Phase conductors and one ground conductor. Phase conductors color-coded, insulated 600-volt XHHW. Ground conductor bare. Sheath-gray neoprene.

Where required, provide Load Transformer Service Units: 480/240/120V, 5kVA single phase, two winding with primary and secondary breakers, provided in each manhole. Encapsulated. Primary connection to terminals in a junction box. Primary Circuit Breaker: 10Amp/2-pole, 480-volt. The secondary connection shall be three 15Amp/1-pole circuit breakers in a junction box. Secondary panel board consisting of four 15Amp/1-pole circuit breakers, 120-volt. Transformer secondary midpoint grounded to the local

Grounding Electrode system. The secondary panel board shall be a listed water-tight submersible enclosure suitable for the installation.

Miscellaneous Devices

1. Auxiliary Wiring: Type XHHW stranded copper No. 12 AWG minimum, except for the cord to the sump pump motor. Cord for sump pump furnished with sump pump.
2. Boxes: listed watertight submersible rated and suitable for the installation.
3. Raceway in Manholes: Rigid galvanized steel conduit with threaded watertight couplings and connectors.
4. All splices shall be sealed in epoxy-encapsulated splice kits.

MEDIUM VOLTAGE CABLE 33 71 49

1. Conductor size (depending on location and voltage rating as defined in 33 70 00, cable ratings may be 25 kV):
   a. Minimum size No. 4/0.
   b. Mandatory Material – all conductors: Copper
2. Insulation: 15kV Class, MV105, 133% BIL rated EPR jacket.
3. Stranded Shield: Extruded semiconducting Ethylene Propylene Rubber (EPR).
4. Shield: Extruded semiconducting EPR, in void-free contact with the extruded insulation.
5. Shield Drain shall be spiral-wrapped copper tape, 0.005 inch thick min. Wrap half-lapped shall not exceed 25 percent.
6. Encapsulating Jacket: Extruded HMWPE, CPE, or PVC outer jacket enclosing the cable assembly.
7. Conductor rating shall be 105 degrees C normal, 140 degrees C emergency, 250 degrees C short circuit conditions operating temperatures. 133% insulation level.
8. The assembly process shall be “triple extrusion” where the strand shield, insulation, and insulation shield are extruded on the conductor in a single operation. All conductors shall be class B stranded, compact concentric.

CABLE CONNECTIONS

Provide Elastimold (or equal) nonload break or Load-Break where specified. All outside terminations shall be glass with skirts. All inside terminations shall have skirts to 5 additional separations. All new connections shall be via separable connectors.

1. Apparatus Connections, 200amp. Used for connection of a feeder, cable 4/0 and smaller, to a device. Consists of the following components:
   a. Apparatus Bushing: Universal Bushing Well. Elastimold No. K1601PC with appropriate shank length, or equal.
   b. Bushing Insert: Elastimold No. 1601A4, or equal.
   c. Elbow Connector: Elastimold No. 166LR Loadbreak Elbow, with grounding adapter and Bailing Assembly, or equal.
2. Apparatus Connections, 600amp. Used for connection of a feeder, cable 250 mcm, and larger, to a device. Consists of Elastimold 650LR apparatus connection with grounding adaptor, or equal.
3. Junction, 600amp, 4 way. Used for joining a combination of cables.

Transition, non-separable splices, and T-Taps are not allowed on campus. Consult with the University Representative for exceptions.

15 kV Cable Splice

1. Types - Splice kits shall be of the heat-shrinkable elastomeric type, Raychem HVS-1520S Series, or the separable connector elbow type, Elastimold 655LR Series, Cooper Power Systems, or equal. Cable splice kits shall be the standard product of a single manufacturer.
2. Materials - Cable splice kits shall contain materials that are completely compatible with the conductors, insulations, shields, and jackets and which are approved by the cable manufacturer.
3. Cable splices shall be suitable for continuous immersion in water.

Medium Voltage Separable Connectors:
Provide ESNA-type connectors with insulated bushings. Elastimold or equal (NonLoad Break). Provide capacitance test point. Connectors shall satisfy the requirements of IEEE 386 and shall be designed for use with the specific cable and type of installation required. The manufacturer shall provide all components and at least two copies of complete directions for assembling and putting the unit into service, (one of which shall be submitted for record).

TESTING

Testing procedures and techniques shall be the responsibility of the Electrical Engineer of Record (EEOR) and shall be coordinated between the EEOR, UCSC Physical Planning Development and Operations, and the UCSC Medium Voltage Electric Shop early in the design process. Various testing procedures are available but any recommendation should follow the IEEE Standard 400-2012. Testing of any existing equipment shall be thoroughly reviewed and analyzed for possible destructive effects on older cable and termination systems. In certain cases, the University may, at its discretion, allow for a lower voltage, less stringent test to avoid any possible damage to existing cables.

If any existing or new medium voltage cables or equipment are planned to be tested, the EEOR or the performing design-build contractor shall submit a recommended testing procedure detailing the testing method (Hi-Pot, VLF, etc.), the applied voltages and durations and test procedure to UCSC Engineering Services and UCSC Physical Plant electric shop at least 45 days prior to performing the test for confirmation of acceptable testing procedures.

High Potential Tests
When a situation occurs where an electrical engineer is not able to provide detailed testing requirements the following are testing procedures for use as University Minimum requirements.
After cables are installed, a high potential test shall be performed on each conductor. An initial voltage shall be applied and increased in no less than 5 uniform steps up to the maximum test voltage. The minimum time at each step shall be no less than required for the test current to stabilize. The high potential test shall be a DC test. If the applied voltage is interrupted at any time during the test on a conductor, the test shall be started again from the beginning. Hold the final voltage for 5 min. Test potentials shall be as follows:

	Nominal Cable Rating	DC Test
Initial Voltage	15kV	15kV
Final Voltage	15kV	63kV

Reports of voltage test results shall be submitted for review with 3 copies of each report prepared in the following format:

1. A separate 81/2 by 11-inch report sheet shall be prepared for each separately tested section of high voltage cable.

2. Each report shall be headed with the project identification.
3. The following additional data shall appear on each report sheet:
   a. Date
   b. Name of the operator performing test
   c. Name of company operator is employed by
   d. Identification of cable tested by listing phase, feeder ID, and end points.
   e. Type of cable insulation
   f. Cable length
   g. Nominal rating of cable
   h. Cable manufacturer and product identification
   i. Size of conductor
   j. Identification of test equipment
   k. Test type
   l. Project identification
   m. Signature of the test equipment operator and the signature of the Contractor.
4. The test results shall be plotted on a log graph and shall have microamperes on the left and kilovolts across the bottom. The graph shall also provide a current vs. time test to be recorded in 1-minute intervals after the final test voltage has been reached.

Insulation Tests - Electrical insulation resistance tests shall be made by the Contractor in the presence of the University's Representative for all new sectionalizing switches using a constant voltage magneto generator capable of measuring 2,000 megohms. Tests shall be made between phase conductors and grounded phase conductors. Insulation resistance shall not be less than 750 megohms. The Contractor shall furnish to the University's Representative a record of all insulation resistance measurements.

MEDIUM VOLTAGE EQUIPMENT INSTALLATION 33 71 50

A. Install cables according to IEEE 576.

B. Prior to commencing with any cable installations (pulls) the installing contractor shall:

1. Clearly identify each phase conductor with colored electrical tape on each end of each cable pulled with the following color scheme:
   - Phase A - Yellow, One Stripe
   - Phase B - Red, Two Stripes
   - Phase C - Blue, Three Stripes

   Identify phase and circuit number of each conductor at each splice, termination, pull point, pull box and manhole. Arrange identification so that it is unnecessary to move the cable or conductor to read the identification.

2. For cable pulls requiring a utility shut down, the contractor shall prepare and distribute a method of procedure (MOP) at least 45days prior to the installation – Which shall include the requirements listed in 33 05 00 and at least the following items:
   a Project Name and PPDO Project Number
   b Location of affected buildings of the shutdown.
   c Location of the work being performed
   d Purpose of the shutdown.

e Date and time of the prerequisite meeting to review the procedures

f Contingency plans at major milestone points if something prevents the MOP from being completed.

g List of people involved in the work to be present and those required for supervision, including the managing supervisor's name, phone number, and email address.

h Revision history block with the version and date of last revision and issuance.

i Page numbers of each page and total number of pages shown on each page.

j List of tools required.

k List of materials required.

l List of necessary Inspections, their approximate durations, and at what time and date these inspections are planned to take place.

m List of cables being pulled identifying the phase, the intended feeder they are planned to serve, the approximate length, the cable type and a complete cable bundle assembly noting quantity and type of conductor and any grounding conductors.

n A copy of the planned and calculated pulling tensions report required in the submittals outlined in this division, section C.

B. Proof conduits prior to conductor installation by passing a wire brush mandrel and then a rubber duct swab through the conduit. Separate the wire brush and the rubber swab by 48 to 72 inches on the pull rope.

1. Wire Brush Mandrel: Consists of a length of brush approximately the size of the conduit's inner diameter with stiff steel bristles and an eye on each end for attaching the pull ropes. If an obstruction is felt, pull the brush back and forth repeatedly to break up the obstruction.
2. Rubber Duct Swab: Consists of a series of rubber discs approximately the size of the conduit inner diameter on a length of steel cable with an eye on each end for attaching the pull ropes. Pull the rubber duct swab through the duct to extract loose debris from the duct. If the rubber duct swab fails to pass through the conduit with reasonable force, notify the electrical engineer of record and the University Representative for direction on how to proceed.

C. Pull Conductors: Do not exceed the manufacturer's recommended maximum pulling tensions and sidewall pressure values.

1. Where necessary, use manufacturer-approved pulling compound or lubricant that does not deteriorate the conductor or insulation.
2. Use pulling means, including fish tape, cable, rope, and basket-weave cable grips, that do not damage cables and raceways. Do not use rope hitches for pulling attachments to the cable.
3. Use pull-in guides, cable feeders, and draw-in protectors as required to protect cables during installation.
4. Do not pull cables with ends unsealed. Seal cable ends with rubber tape.
5. For any cable installation requiring a mechanically powered pulling tool, UCSC requires the use of a dynamometer cable tension gauge on the puller with a real-time display and

a printed or electronic file (i.e. .pdf) output during cable pulls to ensure the manufacturer's recommended tension is not exceeded during the entire duration of the pull. Upon completion of cable pulls, provide a record of tension data covering the full duration of the cable pull at 15-second intervals to UCSC Engineering Services and Electric Shop for review.

6. During cable pulls requiring a dynamometer, the installing contractor shall have a copy of the planned and calculated pulling tensions report on his person for reference and comparison to the real-time tension gauge reading.

D. Support cables according to Section 26 05 29 "Hangers and Supports for Electrical Systems."

E. Install "buried-cable" warning tape 12 inches above cables.

F. In manholes, handholes, pull boxes, junction boxes, and cable vaults, train cables around walls by the longest route from entry to exit; support cables at intervals adequate to prevent sag. Manhole entry and workspace shall not be obstructed by cable routing.

G. Install sufficient cable length to remove cable ends under pulling grips. Remove the length of the conductor damaged during pulling.

H. Install cable splices at pull points and elsewhere as indicated; use standard kits. Use dead-break separable watertight connectors in manholes and other locations subject to water infiltration.

I. Install separable insulated-connector components as follows (junction bars, stacked elbows):

1. Protective Cap (insulated plug with insulated cap): At each terminal junction, with one on each terminal to which no feeder is to be connected.
2. Portable Feed-Through Accessory (parking stand): At each terminal junction, with one on each terminal.
3. Standoff Insulator: At each terminal junction, with one on each terminal.

J. Arc Proofing: arc-proof medium-voltage cable at locations not protected by conduit, cable tray, direct burial, or termination materials. In addition to the arc-proofing tape manufacturer's written instructions, apply arc-proofing as follows:

1. Clean cable sheath.
2. Wrap metallic cable components with 10-mil pipe-wrapping tape.
3. Smooth surface contours with electrical insulation putty.
4. Apply arc-proofing tape in one half-lapped layer with the coated side toward the cable.
5. Band arc-proofing tape with two layers of 1-inch-wide half-lapped, adhesive, glass-cloth tape at each end of the arc-proof tape.

K. Seal around cables passing through fire-rated elements according to Section 07 84 13 "Penetration Firestopping."

L. Install fault indicators on each phase where indicated. (This is generally done on isolation load switchways. See fault indicator section.)

M. Ground shields of shielded cable at terminations, splices, and separable insulated connectors. Ground metal bodies of terminators, splices, cable and separable insulated-connector fittings, and hardware.

N. Medium Voltage Feeder Design: All 12kV ungrounded delta-connected MV feeders shall be run with a bare or insulated copper, minimum #4 AWG equipment grounding conductor within the conduit unless the following applies: The metallic insulation shield encircling the current-carrying conductors shall be permitted to be used as an equipment grounding conductor if it is rated for the clearing time of the ground fault current protective device operation without damaging the metallic shield. Whichever method is used, the Electrical Engineer of Record shall provide supporting calculations and code references that determine the size of the equipment grounding conductor.

PROHIBITED CONSTRUCTION:
The following medium voltage construction techniques shall be strictly prohibited.

1. T-Tap or T-Splicing cables to extend to a third path/feeder shall be strictly prohibited.
2. Stacking modular connectors or elbows shall be prohibited. In situations where there is not enough time or funding to engineer a pad mount switch, at a minimum, the design shall incorporate dead break junction bars – 600amp minimum rating.

MV CABLE INSTALLER AND SPLICER QUALIFICATIONS:
In addition to requirements in Division 1 of the Campus Design Guide, medium voltage equipment, all installers, and splicers must be prepared to show the qualifications listed below during the MOP submittal process listed in section 33 71 50 Paragraph B 2.

A. An industry-accepted certificate of achievement in a nationally recognized training or certification program relevant to the medium voltage work to be performed.
B. Proof of completion of a formal/recognized apprentice program that includes, but is not limited to splicing and terminating various types of cables, installing maintaining, and repairing various types of medium voltage electrical equipment used in Underground Commercial Distribution (Network) Systems
C. A list of 5 similar projects and the tasks completed related to the medium voltage work proposed to be performed.
D. Installing company must hold a California C-10 electrical contractor license experienced in the installation of medium voltage cables and equipment (minimum 5 years).
E. Installer shall have an office, which has been in existence for at least 3 years, within a 100-mile radius of the job site. The University may reject any proposed installer who cannot show evidence of such qualifications.

MEDIUM-VOLTAGE TRANSFORMERS 33 73 13

SERVICE TRANSFORMERS, PAD MOUNTED
Coordinate location and ratings with division 33 70 00, if 21 kV service is developed change the transformer rating to 25 kV, otherwise provide 12 kV rated equipment. Dead front pad mounted unit transformer (PMT), front access only, self-cooled, oil insulated, complying with the ratings. Transformers shall be installed so they are not visible to the general public (behind walls or concealed by other means). Because of storm-water and roadway requirements, if an oil-filled transformer is proposed, the Design Professional shall request the requirements for containment from the University Representative.

Clearance:
Maintain 8 feet working clearance in front of all transformers.

Ratings:

Primary Voltage	12,470 volts

Secondary Voltage	Specify on Drawings
Primary Windings	Three Phase Delta, copper
Secondary Windings	Three Phase Wye, copper
Continuous kVA Rating	Specify in Schedule and on Drawings
Primary BIL	95kV, minimum
Secondary BIL	30kV, minimum

Primary Connection
Loop feed, six 200-amp universal busing wells minimum.

Primary Switching
Three, 2 position load break, load make switches; a switch for feeder A side, a switch for feeder B side, and a switch for transformer winding load. Primary switches, arranged as shown on the Drawing. Switches rated 200-amp continuous, 6000 amp for 1 second (minimum). Coordinate with UCSC PPDO whether or not the switch will serve as a loop feed-through arrangement. In cases where the switch serves as a loop feed through, make before break, change the rating to 600 amp.
Primary Fusing - Internal Fault Protection: Current limiting fuses, Class E, in-tank installed. Overload Protection: Expulsion fuses, dead front installed BayONet. Furnish one spare set of fuses in original cartons.

Primary Taps & Tap Changing
Four full capacity primary taps, 2.5 percent each (2 taps above & 2 taps below operating voltage), with externally operated, no load tap changing switch. Switch with tap connection indicating plate readable from 5 feet away.

Secondary Connections
Spade bushings: National Electrical Manufacturers Association (NEMA) drilled copper terminal, 1.75 inch hole spacing. Provide secondary bus supports using an insulating material to prevent the spade from bending due to cable weight.

Terminal Compartments
Provide terminal compartments enclosing primary and secondary cable connections and transformer auxiliary equipment. Compartments constructed of formed steel with full-width and height doors for each compartment.

Compartment dimensions are as follows:

Height: The maximum of 66 inches or the transformer height plus 2 inches (approx.)
Depth: 18 inches minimum, 24 inches maximum.
Width: Primary Compartment 42 inches min.; Secondary Compartment 24 inches min.

Finish
Prior to prime coating, all welds shall be ground smooth. Rust-inhibiting prime coat over cleaned and degreased surfaces. Vinyl paint for finish coat on all surfaces. The color shall be Munsell No. 7GY3.29/1.5 Green.

Latches
Transformer access shall be secured with a penta-head retaining bolt.

Grounding Pads
Steel ground pad welded to tank wall in primary and secondary compartments. Each pad drilled and tapped for two 3/8 inch (min.) steel bolts.

Auxiliary Devices

The following is auxiliary equipment to be furnished by the transformer manufacturer with the transformer.

1. Pressure relief valve.
2. Oil Level Gauge: With normal level at full load rated temperature rise indicated.
3. Oil Temperature Gauge: Calibrated in deg. C, with full load temperature rise indicated.
4. Bronze Drain and Sampling Valve: 1-inch trade size, minimum, with FPT plugged discharge.
5. Oil Fill Connection: Capped, 1.25-inch trade size, minimum.
6. Ground Connection Pads: One each in primary and secondary compartments, drilled and tapped for two 3/8 inch steel bolts (minimum) each.

Ratings:

Do not specify fan-assisted and rated oil-filled transformers.

Testing

Field testing requirements for oil-filled transformers include ASTM D877 dielectric liquid test and other NETA requirements.

CAST COIL DRY TRANSFORMERS

Building service entrance transformers can be air-cooled dry-type dual-rated OA indoor or outdoor units located next to buildings. The requirements for Service Transformers, Pad Mounted apply except as modified below. Coordinate with the University Representative if a cast coil or oil-filled transformer is required.

Primary Winding cast in Epoxy Resin
Secondary Winding Encapsulated in Epoxy Resin
Core of laminated transformer steel
Enclosure Ventilated Steel with hinged doors and access panels

Ratings

Secondary BIL	10kV
Secondary Connection Arrangement	Wye
Rated Ambient Temperature	40 deg. C
Rated Temp Rise, Base Rating	80 deg. C
Base kVA Rating	As Called for
Overload Rating	130 percent of Base kVA rating (min)
Maximum Losses No Load	As called for
Load	As called for

Setting and Mounting

The assembly is to be constructed on a steel channel base arranged for four-point mounting only. The unit provided is complete with vibration-isolating mountings. The units each furnished complete with required anchor bolts.

Primary Service Cable

Shielded copper cable entering vertically on the primary end. Cable connected to the transformer primary bussing with two-hole NEMA spade pressure connectors. Cable insulation and shield shall be terminated in a slip-on stress cone terminator.

Secondary Service Cable

Copper cable entering vertical on the secondary end.

MEDIUM VOLTAGE UTILITY SWITCHGEAR AND PROTECTION DEVICES	**33 77 00**

CIRCUIT INTERRUPTERS

Three-phase circuit interrupters for automatic overcurrent protection of 12 kV underground feeders and for remote manual switching of a circuit. Unit shall be controlled with the electronic control panel included with the assembly, and a field-constructed push button control station.

Tripping and closing signals are initiated from the control unit. Signals from the control unit energize the operating circuits in the recloser and release the stored energy trip mechanism when an overcurrent occurs. Recloser units and control panels shall be mounted on the wall of the manhole and remote manual control units shall be mounted at the manhole entrances. Some circuit interrupters may require protection on an incoming or outgoing way. Protection shall be coordinated with the distribution system, see the section on Distribution System Protection Relaying earlier in this division and consult with the University Representative for integration into the campus distribution grid.

Most installations do not require a fault interrupting capability on any medium voltage switchways. However, long-term future development plans may require them. The engineer of record shall coordinate with the UCSC Engineering Services and UCSC MV Electric shop on whether or not a Fault Interrupting switch shall be required for each particular project.

G&W Electric or equal (basis of design). Verify with the University Representative if the switch will serve as a loop connection necessitating an upgrade to 600 amp features in lieu of 200 amp.

1. Ratings (Non loop-feed):

Operating Voltage	Continuous Current	Interrupting Current	Momentary Current	Control Voltage
12kV	200	12,000A	6,000 (min)	120 volts

2. Vacuum Interrupter: The Interrupter unit is to be vacuum style, controlled by stored energy trip and close mechanisms. Contacts to be copper alloy material.
3. Electronic Control Panel Enclosure: Type National Electrical Manufacturers Association (NEMA) 12 rain-tight enclosure mounted on a manhole wall.
4. Manual Control: Provide the following manual control functions:
   a. Electric operated trip and close, with control switch at the Control Panel, with flag indication of interrupter open or closed.
   b. Mechanical trip and close, operable without control power from either the line switched or a remote power source.
   c. Interrupter pad-lockable in the open position.
   d. All operators shall be able to be padlocked.
5. Automatic Control (where required): Provide the following functions: all field settable:
   a. Phase over current, inverse time trip setting per EEOR.
   b. Ground over current, inverse time trip setting per EEOR.
   c. Inrush restraint on phase and ground trips.
   d. Provide an indication of the cause of trip.
6. Primary Connections: Universal bushing wells, 200 amp (or 600 amp if designated loop-feed), each with a parking stand. If 600 is used, provide reducing bushing for grounding.
7. Vacuum Circuit Switching Unit: The unit comes with electric and manual operation. Unit is an assembly of frame-mounted vacuum switching bottles, current sensing transformers, auxiliary

switches, and electric operator with oil insulation in steel housing. Unit to have dead front construction and lifting lugs.

8. Low voltage closing solenoid to be installed to provide contact closing energy.
9. Universal bushing wells: Compatible with all industry-standard plug inserts for load break and non-load break separable cable connectors rated for 200-amp, 15 kV service. Recloser to be supplied with the following bushing arrangement: 200-amp wells load and source.
10. Low Voltage Closing: Include equipment for internal operation of low voltage DC closing solenoid and associated wiring.
11. Auxiliary Switch: For remote indication of recloser contact position or switching. Three-stage switch to be mounted on the recloser frame.
12. Bushing Type Current Transformer: Multi ratio current transformers to be factory installed on load side bushings. Primary/secondary current ratios of 600:5 are to be provided. Secondary taps are to be factory-wired to terminal blocks on the control panel.
13. Control Cable: As required for sensing and control between the Recloser and Control Panel and to bring the auxiliary contacts to the control panel. Cable Connection to Recloser shall be waterproof, connection to the Control Panel with screw connectors.
14. Mounting Bolts for Recloser: Four 1/2 inch by 6-inch hex head expansion bolts, with 4 1/2 inch expansion anchors. Bolts and anchors galvanized or cadmium plated.

Recloser Ratings Vacuum Switching Unit

Number of poles	3
Voltage	15kV, 3 Phase
Current, normal	200 Amp
Current, interrupting	200 Amp
Current, 1 Second	12,000 Amp
Operation	Spring stored energy trip and close
Instrument Transformers	Phase current and ground Current.
Spring Charging	24-Volt DC Universal Motor
Test Voltage AC 1 min.	35kV
Test Voltage DC 15 min	55kV
No. of operations at Rated current	230
Control Voltage	24-Volt DC

Electronic Control Panel Assembly - A unit for automatic over-current operation (where required) and remote manual operation of the switching unit. Control to include accessories for remote close with cold load pickup and annunciator type target; automatically reset; phase and ground.

1. Control Power Supply: Provide self-contained, internally supplied control power.
2. Ground Connection Fitting: 1/4 inch by 1-inch steel stud bolt welded to the enclosure.
3. Control Unit Enclosure: The Control Panel Assembly shall be mounted in a type 12 NEMA weatherproof cabinet with a hinged, captive bolt fastened door, with provision for padlocking closed. Finish coat of epoxy enamel.

Remote Manual Control Station (For underground installations only, where required on construction documents):

1. Pilot Light Station, 2 lights, 1 push button switch. Station in cast gasketed submersible enclosure. One light RED and 1 light GREEN, each with lamp transformer and lamp, labeled OPEN and

CLOSED. Pushbutton switch 2 position momentary contact labeled LAMP TEST. Units General Electric CR103J, Square D, or equal.

2. Push Button Control Station - Heavy Duty, Oil-tight pendant type Control Station. Each station two unit, each unit two position momentary contact, depress to close, in a steel enclosure. Push button switches labeled OPEN and CLOSE. Units General Electric Model CR2940 FG202A, Square D, or equal.
3. Retractile Cord - Four conductors No. 18 AWG Type SJO coiled retracting cord, 48-inch coiled length extensible to 25 feet. Cord Belden NO. 9483, Alpha Wire Co., or equal.
4. Control Station Hook - For supporting the Push Button Control Station of the roof of the manhole available to the operator. Galvanized open hook bolt, 3/16 inch, installed in an after-set insert nut. The nut is to provide not less than 2 inches of concrete penetration.
5. Remote Manual Control Provide a remote trip and close push button control station for each interrupter as follows:
    a. Two-unit push Pilot Light indicating interrupter OPEN and interrupter CLOSE operation on the control box.
    b. Two-unit push button station for interrupter TRIP and interrupter CLOSE operation.

PAD MOUNTED MEDIUM VOLTAGE SWITCH AND VACUUM INTERRUPTER COMBINATION
Switches shall be designed, tested, and built in accordance with ANSI C37.72. Each switch assembly shall be rated as follows:

Max. design voltage, kV	15.5
Impulse level (BIL), kV	95
Cont. & loadbreak, Amps	600
1 min., withstand, AC kV	34
15 min. withstand, DC kV	53
Mom. Current, kA Asym.	20
Fault-close, kA Asym.	20
1 sec. Current, kA Sym.	12
10 operation overload interrupt capability, A	2,000
Load interrupt, endurance at 600A, Operations	10,000

Switch Construction: All switch components and entrances shall be assembled in a totally welded 7-gauge #304 stainless steel tank. Entrances shall be internally connected and capable of handling momentary and continuous current duty. The switch shall contain no electrically floating metallic parts or components. Switches shall be shipped factory-filled with #10 insulating oil. Tank shall be designed to withstand 7 psig internal pressure and an external pressure of 7 psig without affecting the performance of the switch.

Cable Entrances: Cable entrances shall be tested to IEEE 386 Standard for Separable Insulated Connector Systems for Power Distribution Systems Rated 2.5 kV through 35 kV and be 600A apparatus bushings.

Switch Operation

1. Each switching way is to be equipped with an internally mounted operating mechanism capable of providing quick-make, quick-break operation in either switching direction. The mechanism

shall use compression-type springs to assure long life and reliability. All switch positions are to be clearly identified and pad-lockable.

2. The operating mechanism shall be actuated from outside the switch tank by a stainless-steel operating handle.
3. The operating shaft shall be made of stainless steel for maximum corrosion resistance. A double "O" ring type operating shaft seal shall be used for a leak-resistant, long-life seal.

Switch Contacts: Switch contacts shall be made of copper/tungsten alloy to assure permanent low resistance and to avoid sticking during operation. Temperature rise shall not exceed ANSI C37.72 standards for this type of device.

Factory Production Tests: Each individual switch shall undergo a mechanical operation check, and leak detection test. The switch shall be AC hi-pot tested 1-minute phase-to-phase and phase-to-ground and across the open contacts. Circuit resistance shall be checked on all ways. A copy of the test report shall be delivered to UCSC Physical Planning prior to installation of the switch with the date and serial number clearly identified on the report.

Vacuum Interrupter: The vacuum interrupter shall be a non-reclosing, manual reset device incorporating vacuum bottles. It shall be designed, tested, and built per applicable sections of ANSI C37.60. The vacuum interrupter assembly itself shall be rated:

Max. design voltage, kV	15.5
Impulse level (BIL), kV	95
Cont. & load break, Amps	200 or more
1 min., withstand, AC kV	34
Sym. Interrupt rating, kA	12
Momentary rating, kA	20

ANSI C37.60 Fault Interrupting Duty

Percent of Maximum Interrupting Rate	Approx. Interrupting Current, Amperes	Number of Fault Interruptions
15-20 percent	2,000	44
45-55 percent	6,000	56
90-100 percent	12,000	16
Total # of Fault Interruptions: 116		

Vacuum Interrupter Operation

1. The vacuum interrupter shall consist of a vacuum bottle and a spring-assisted operating mechanism.
2. The vacuum interrupter operating mechanism shall consist of the support assembly, linkage, spring latch mechanism, and solenoid utilized for electronic tripping. Interrupting time shall be three cycles maximum (50m Sec).
3. Each tap phase is to be equipped with an individual vacuum interrupter fully enclosed in an oil-insulated switch tank. Electrical opening of the vacuum interrupter shall be by a solenoid that is activated from the control box external to the switch tank. Electrical opening shall be field selectable. Closing (reset) of the vacuum interrupter shall be manual with the use of a mechanical lever.

4. The mechanical linkage assembly shall provide for a "trip-free" operation that allows for the vacuum interrupter to interrupt independently of the operating lever if closing into a faulted or heavily loaded phase or circuit. Interruption or reset shall be three-phase.

Enclosure

1. The enclosure for the switch assembly shall be made of 11-gauge #304 stainless steel and manufactured to ANSI C37.72 and C57.12.28 standards. After assembly, the enclosure shall be finished with a coating of UV-resistant paint.
2. The enclosure shall be provided with four lifting eyes that provide a balanced lift for the complete assembly.
3. Enclosure access doors shall have stainless steel hinges. Access doors to the power cable compartments shall be equipped with a latch mechanism and penta-head bolt assembly.

Standard Components

1. Four lifting provisions.
2. Welded entrance bushings.
3. Grounding provisions for one 1/2-inch – 13 ground connection per switch way plus provisions for one 1/2-inch – 13 tank ground connections.
4. Three-line diagram and stainless steel nameplate, permanently mounted.
5. Stainless steel enclosure, stainless steel, and brass fasteners, with no external aluminum parts.
6. Enclosure coating to be light gray (ASA 70) paint with primer, 3-mil-thick minimum.
7. Pad-lockable operating mechanism with position indication.
8. Phase designation nameplates.
9. Open/closed indicators mounted to the moving interrupter shaft.

Field Testing:

Provide the services of a factory representative to test switches and interrupters. The test shall include:

1. Insulation test using 2,500 VDC source.
2. High potential test: Test each pole to be ground for 1 minute at 75 percent of DC test conducted at the factory. The University will furnish records of previous factory test results.
3. Contact resistance test across each switchblade.
4. Operation test of all switch and vacuum interrupters.

MEDIUM VOLTAGE LOAD BREAK SWITCHES (SECTIONALIZING SWITCHES)

Three phase 600 amp, used for 12.47kV underground feeders and for remote switching of a circuit. Each unit shall be manufactured by G&W, no known equal, Trident solid dielectric and controlled by an electronic control panel furnished with the assembly, and a remote push-button control and Pilot Lamp station. The complete assembly, including the control panels, shall be capable of operation, without damage, when fully submerged in water to a depth of 5 feet.

Ratings

Operating Voltage	15,500 volts line to line
BIL	95kV
AC Withstand, on minute	35kV

DC Withstand, 15 minutes	53kV
Continuous Current	600 amps
Fault Current Interrupting	12000 amps
Min. # of Fault Operations (50 percent rating at X/R= max.)	100
Control Power, from external source	120 volts a.c.
Cable Connections	600-amp bushing for separable connection

Provide ground connection fittings, remote manual control panel station and enclosure, and manual control features as required under CIRCUIT INTERRUPTER above. In addition, provide:

1. When required for automatic control - Provide the following functions, all field settable:
    a. Phase overcurrent, inverse time trip - curve C, 200 amp minimum trip.
    b. Phase Current instantaneous trip, adjustable with dip switch field set at a multiple of minimum pick up. Set for 1 b times minimum pick up.
    c. Ground overcurrent, inverse time trip - curve 1, 20 amp minimum trip.
    d. Inrush restraint on phase and ground trips.
2. Annunciation - Provide a labeled flag to indicate phase, ground fault, or instantaneous trip initiation.
3. Auxiliary Switch - Provide a four-circuit (2 Form A, 2 Form B) auxiliary switch, with cable connection to terminals in the Control Panel.

Execution

1. Interrupter Installation in Manholes - Mount either horizontal on wall or on the floor depending on manufacturer configuration.
    a. Cable Connections – Refer to section 33 71 49 above for requirements. Cable to be trained and tied in such a configuration that the connecting fitting can be pulled without undoing or relocating the cable bundles.
    b. Control Cable termination - Control cable to be terminated in the Interrupter at the factory. Terminate the free end in the Electronic Control Panel with factory factory-installed cord grip connector.
2. Control Panel Assembly Installation - Obtain control power from the manhole auxiliary power circuit. Connections to circuit shall be watertight. Setting and adjustment of the electronic relays will be done by the University.
3. Manual Remote Control
    a. Install the remote manual control devices to permit the opening and closing of the interrupter from outside the manhole while observing the lamps indicating open or closed condition of the interrupter. Install device suspended on a hook called for at a location convenient to the operator to grasp from the manhole access ladder. Location shall be approved by the University’s Representative prior to installation.
    b. Control Wiring - Run in Galvanized Steel conduit.

Primary Sectionalizing Switches: The sectionalizing switches shall be G&W Trident (no known equal) solid dielectric type rated 15,000 volts, 600 amperes, load break 40,000 amperes momentary. Switch shall have the minimum quantity of ways to switch all feeder circuits involved in the project plus one additional spare for the future. Each way shall be 3pole, 2position, “onoff” position. Cable entrances shall be through the top and shall be apparatus bushings with ESNA type 600-amp elbow connectors for single conductor as required. Handle on each way of each switch shall be fitted with a spring operator.

The switch shall be mounted on a frame to the wall in the manhole and shall be complete. The switch shall be furnished with provisions for padlock interlock on the outside ways of the switch and shall prevent motion of this way to any position without the key.

TESTING

Testing procedures and techniques shall be the responsibility of the Electrical Engineer of Record (EEOR) and shall be coordinated between the manufacturer, the EEOR, UCSC Physical Planning Development and Operations, and the UCSC Medium Voltage Electric Shop early in the procurement process. Various testing procedures are available but any recommendation should follow applicable IEEE Standards.

Regardless of the recommendations of the EEOR, the following minimum field tests shall be performed unless alternate methods specifically agreed on in writing by the EEOR and UCSC have been approved.

A NETA-certified 3rd party testing agency familiar with the equipment shall test switches and interrupters as follows:

1. Insulation test using 2,500 vdc source.
2. High potential test: Test each pole to be ground for 1 minute at 95 percent of DC test (75% for pad-mount switches) conducted at the factory. The University will furnish records of previous factory test results if applicable.
3. Contact resistance test across each switchblade.
4. Operation test of all switch and vacuum interrupters.

A copy of the test report shall be delivered to UCSC Physical Planning with the date and serial number clearly identified on the report.

Upon a successful test result of the above 4 requirements, the following functional performance field tests will be performed by the contractor in the presence of the University Representative.

1. Manual Trip and close tests from each location where this function is specified.
2. Automatic trip test using simulated fault current if fault current interrupters are installed.

MEDIUM VOLTAGE DUCT BANK GROUNDING 33 79 83

In the core campus area, install a 2/0 copper conductor (or larger) in all H/V duct banks. The 2/0 conductor shall be attached to the ground rods placed in the duct bank system. Ground rods shall be installed in splice locations and all equipment and material in these locations shall be bonded to the 2/0 copper conductor.

GROUND BONDS
Ground Bus to Trans Neutral Two No. 2/0 AWG
Ground Bus to transformer enclosure, distribution panel enclosure, cable box cover, trench cover and ground electrode loop No. 2/0 AWG

GROUND RODS
Copper clad steel rods, 1-inch by the required dimension, in sectional 10-foot lengths with pointed end, driven to a depth where the rod top is not less than 6 inches below finish grade at the equipment pad and two inches above the floor in the equipment manhole. Protect the rod top with a driving tool while driving to prevent deformation or other damage.

CABLE CONNECTIONS

1. To Ground Rods Exothermic weld, Cadweld or equal, utilizing weld molds furnished by the weld manufacturer and the type and size recommended by the weld manufacturer.

2. Ground Cable Splices Exothermic weld, Cadweld, or equal, utilizing molds of the type and size recommended by the weld manufacturer.
3. To Ground Buses and to Equipment Pressure indented copper cable terminal, one hole: Burndy HYLUG, T&B Blue, or equal. Install with inch galvanized or cadmium-plated steel machine bolts with a beveled washer on each side.

TESTING

Grounding test shall be by the fall-of potential method by a NETA certified 3rd party testing agency. Reports shall be provided as per Division 1 submittal procedures.

The following standard specification is intended to be edited according to the specifics of the project. Brackets [ ] and areas shaded in gray [e.g. format] indicate requirements that are optional depending upon the type of system being provided or per instructions associated with the [ ] and project requirements. Consult with University's Representative and campus stakeholders.

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SECTION 33 08 10
COMMISSIONING OF WATER UTILITIES

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Acceptance checklist for commissioning of water utilities prior to putting water lines into service.

1.2 RELATED SECTIONS

A. Section 01 33 23 Shop Drawings, Product Data and Samples

B. Section 01 91 00 Commissioning

C. Section 33 11 00 Campus Water Utility Distribution System

D. Section 33 12 13.13 Backflow Preventers

E. Section 33 13 00 Domestic Water Piping Disinfection

1.3 SUBMITTALS

A. See Section 01 33 23 Shop Drawings, Product Data and Samples for submittal procedures.

B. Submit Form XXXX of Section XX XX XX with all items on checklist completed, prior to commissioning.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 COMMISSIONING CHECKLIST

A. Submit a copy of contract drawings marked up to show interim “As Built” conditions to the University’s Representative for review with UCSC Engineering Services. These drawings shall include valve and hydrant numbers.

B. Conduct a job site meeting with the University's Representative, Contractor, and University Utility staff to review the Commissioning Checklist.

C. Field verify that the interim “As-Builts” are correct, the water system was installed per contract, and all utility structures and control points are marked and numbered per the interim “As-Builts”.

D. Field verify that all valve boxes are set to grade so that they will not collect rainwater, and are properly labeled and painted.

E. Provide documentation that all fire hydrants have been flow tested and accepted by the Designated Campus Fire Marshal.

F. Field verify that all fire hydrants are set to grade, properly labeled, properly oriented, and painted .

G. Verify that pipelines have passed hydrostatic and leakage tests per section 33 11 00 Water Utility Distribution Piping.

H. Verify meters have been calibrated and documentation submitted.

I. Obtain final water and electric meter readings when Contractor is no longer responsible for the utility use.
J. Verify backflow devices have been tested, passed and documentation submitted. Certification of backflow devices by a certified backflow tester is required. Verify they have been painted and insulation blankets provided as required.
K. Verify pipelines have been flushed and passed disinfection per section 33 13 00 Disinfection of Domestic Water Piping.
L. Verify all utility structures in active construction areas have been adequately marked, protected, and kept accessible to University at all times.
M. Verify that all temporary water connections have been removed or left as agreed by University's Representative.
N. Provide copies of Operations and Maintenance manuals as required.
O. Provide spare parts and special tools as required.
P. Provide training as required.
Q. Utility Activation
    1. The contractor shall submit a written utility activation request at least 5 days prior to the requested date of activation to the University Representative. The request shall clearly indicate which lines or systems are being requested to be placed into service.
    2. List any remaining work to be completed and the anticipated date of completion in the utility activation request.
    3. Conduct a job site meeting with the University's Representative, Contractor, and University Utilities staff.
    4. Review the utility activation request, the Commissioning Checklist and verify all items have been completed or incomplete items are listed in the utility activation request.
    5. Review any special considerations for activating the utility.
    6. Utilities staff will activate the utility after all of the commissioning items have been completed.

END OF SECTION 33 08 10

The following standard specification is intended to be edited according to the specifics of the project. Brackets [ ] and areas shaded in gray [e.g. format] indicate requirements that are optional depending upon the type of system being provided or per instructions associated with the [ ] and project requirements. Consult with the University's Representative and campus stakeholders.

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SECTION 33 08 30
COMMISSIONING OF SANITARY SEWER UTILITIES

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Acceptance checklist for commissioning of sanitary sewer utilities prior to putting sewer lines and small package sanitary sewer pumping stations into service.

1.2 RELATED SECTIONS

A. ADD SECTION WHERE EXHIBIT FORM WILL BE LOCATED

1.3 REFERENCES (NOT USED)

1.4 SUBMITTALS

A. See Section 01 33 23 Shop Drawings, Product Data and Samples for submittal procedures.
B. Submit Form XXXX of Section XX XX XX with all items on the checklist completed, prior to commissioning.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 COMMISSIONING CHECKLIST

A. Submit a copy of contract drawings marked up to show interim “As Built” conditions to the University's Representative for review by University Facilities Management Engineering Services. These drawings shall include valve and hydrant numbers. Hold a meeting at the job site with the University’s Representative, the Contractor, and the UCSC Physical Plant staff to review the Commissioning Checklist.
B. Field verify that the interim “As-Builts” are correct, that the sewer system was installed per contract, and that all utility structures and control points are marked and numbered per the interim “As-Builts”.
C. Field verify that all manholes and cleanouts are set to grade and properly labeled.
D. Verify that manholes have been visually inspected, leak tested, and passed.
E. Verify that gravity pipelines have been leak-tested and passed.
F. Verify that pipelines have been flushed.
G. Verify that gravity pipelines have been deflection tested and passed.
H. Verify that gravity pipelines have been video camera inspected and passed.
I. Verify that force mains have passed hydrostatic and leakage tests.
J. Verify that pump stations have been performance tested and passed.
K. Verify that pump station wet wells have been leak-tested and passed.
L. Verify that flow meters have been calibrated.
M. Verify all utility structures in active construction areas have been adequately marked, protected,

and kept accessible to University staff at all times.

N. Verify that all temporary sewer connections have been removed or left as agreed by University Utilities staff.
O. Field-verify the Post-Construction Measures have been installed per contract.
P. Provide copies of Operations and Maintenance manuals as required.
Q. Provide spare parts and special tools as required.
R. Provide training as required.
S. Utility Activation.
    1. The Contractor shall submit a written utility activation request at least 14 calendar days prior to the requested date of activation. The request shall clearly indicate which lines or systems are being requested to be placed into service.
    2. List any remaining work to be completed and the anticipated date of completion in the utility activation request.
    3. Hold a meeting at the job site with the University's Representative, Contractor, and University Utilities staff.
    4. Review the utility activation request, the Commissioning Checklist and verify all items have been completed or incomplete items are listed in the utility activation request.
    5. Review any special considerations for activating the utility.
    6. Utilities staff will activate the utility after all of the commissioning items have been completed.

END OF SECTION 33 08 30

The following standard specification is intended to be edited according to the specifics of the project. Brackets [ ] and areas shaded in gray [e.g. format] indicate requirements that are optional depending upon the type of system being provided or per instructions associated with the [ ] and project requirements. Consult with the University's Representative and campus stakeholders.

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SECTION 33 13 00
DISINFECTION OF DOMESTIC WATER PIPING

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. This specification applies to the installation of all new and repaired potable (domestic) water lines. All new domestic water lines shall be disinfected before they are connected to existing piping and placed in service. All domestic water lines taken out of service for inspection, repair, or other activities that might lead to contamination of water shall be disinfected before they are returned to service.

B. Except as specifically noted, the Contractor shall furnish all labor, equipment, and materials to prepare, disinfect, and test domestic water lines in conformity with the procedures and standards described in this section.

1.2 REFERENCES

A. American Water Works Association (AWWA) C651- AWWA Standard for Disinfecting Water Mains and applicable local and government regulations.

B. AWWA B300 – Hypochlorites

C. AWWA M12 - Simplified Procedures for Water Examination – Fifth Edition

D. Standard Methods for the Examination of Water and Wastewater

1.3 SUBMITTALS

A. Submit a Disinfection Plan describing flushing procedures; type, form, and dose of disinfectant to be used; proposed locations for adding disinfectants and collecting disinfection verification samples; final flushing procedures; and the Sanitary Sewer location for disposal of flushing water.

B. Following completion of disinfection, provide a Disinfection Certification Report confirming compliance with specifications to the University’s Representative. This report, together with acceptable disinfection verification sample results collected and analyzed by the University's Representative will form the basis for approval of disinfection.

C. Submit in accordance with Section 01 33 23 Shop Drawings, Product Data, and Samples.

1.4 SUPERVISION AND TESTING

A. Disinfection shall not commence until the University's Representative has accepted the Disinfection Plan. The University’s Representative shall supervise the start of disinfection and the conclusion of the disinfection retention period.

B. Unless otherwise approved by the University's Representative the final disinfection verification water samples will be collected by the University's Representative with analysis performed by a California Department of Health Services laboratory selected and paid for by the University. The Contractor shall assist the University's Representative in completing this task.

PART 2 - PRODUCTS

2.1 MATERIALS

A. The following forms of chlorine are approved for use as disinfecting agents:
    1. Sodium hypochlorite in liquid form, conforming to American National Standards Institute/American Water Works Association (ANSI/AWWA) B300.

B. Contractor shall comply with all applicable local, state, and federal regulations concerning transport, handling, and reporting of the materials used for disinfection.

PART 3 - EXECUTION

3.1 PREVENTIVE AND CORRECTIVE MEASURES DURING CONSTRUCTION

A. General. The procedures of this section shall be observed to ensure that water pipelines and appurtenances have been thoroughly cleaned for the final disinfection by chlorination. New pipelines shall be isolated until bacteriological tests described in this section, are satisfactorily completed and disinfection is approved by the University's Representative.

B. Keeping pipe clean and dry. The interiors of pipes, fittings, and valves shall be protected from contamination. Pipe delivered for construction shall be strung to minimize the entrance of foreign material. All openings in the pipelines shall be closed with water-tight plugs when pipe laying is stopped at the close of the day’s work or for other reasons, such as rest breaks or meal periods. Rodent-proof plugs may be used when watertight plugs are not practicable and when thorough cleaning will be performed by flushing or other means.

C. Packing materials. Yarning or packing material shall consist of molded or tubular rubber rings, rope of treated paper, or other approved materials. Materials such as jute or hemp shall not be used. Packing material shall be handled in a manner that avoids contamination. Packing materials are only acceptable if specified as part of the piping system and provided in accordance with piping requirements specified in other sections of the specifications.

D. Sealing materials. No contaminated material or any material capable of supporting the prolific growth of microorganisms shall be used for sealing joints. Sealing material or gaskets shall be handled in a manner that avoids contamination. Sealing materials are only acceptable if specified as part of the piping system and provided in accordance with the piping requirements specified in other sections of the specifications.

E. Cleaning and swabbing. If dirt enters the pipe, it shall be removed and the interior pipe surface swabbed with a 1 to 5 percent hypochlorite disinfecting solution. If in the opinion of the University’s Representative, the dirt remaining in the pipe will not be removed using the flushing operation, then the interior of the pipe shall be cleaned using mechanical means, such as a hydraulically propelled foam pig (or other suitable device acceptable to the University’s Representative in conjunction with the application of a one percent hypochlorite disinfecting solution. The cleaning method used shall not force mud or debris into the interior pipe-joint spaces and shall be acceptable to the University’s Representative.

F. Flooding by storm or accident during construction. If the pipeline is flooded during construction, it shall be cleared of the floodwater by draining and flushing with potable water until the main is clean. The section exposed to the floodwater shall then be filled with chlorinated potable water that, at the end of a 24-hour holding period, will have a free chlorine residual of not less than 25 mg/L. The chlorinated water may then be drained or flushed from the pipeline. After construction is completed, the pipeline shall be disinfected using the continuous-feed method.

3.2 METHODS OF CHLORINATION

A. General. The continuous feed method shall be used for disinfection. AWWA’s "tablet method" and "slug method" are not allowed. All valves, faucets, and fixtures shall be installed and piping installation shall be completed before chlorination is initiated.

B. Notification and Scheduling. Contractor shall notify the University’s Representative of their intent to begin the disinfection process. Prior to scheduling this work, the disinfection submittal shall have been approved by the University. The Contractor will coordinate the disinfection, final flushing, and disinfection verification sampling with the University's Representative at least 72 hours prior to commencing chlorination. Disinfection verification sampling shall be scheduled only on Mondays, Tuesdays, Wednesdays, or Thursdays and be completed prior to 3:30 P.M.

C. Preflushing of source water. The source water (typically a University fire hydrant) used for disinfection and pressure testing shall be flushed prior to its use to ensure that contaminants or debris are not introduced into the new pipe. Flushed water shall not be discharged, either directly or indirectly, into campus storm drainage systems. Flushed water shall either be discharged into the campus sanitary sewer system or managed in a manner to retain the water on site. The University's Representative will provide the Contractor with a location to discharge flushing water during the formation of the Disinfection Plan.

D. Preliminary flushing. Before the pipeline is chlorinated, it shall be filled to eliminate air pockets and flushed to remove particulates. The flushing velocity in the pipeline shall not be less than 2.5 ft/s unless the University's Representative determines that conditions do not permit the required flow to be discharged to waste. As practical, as determined by the University's Representative, all fixtures shall be flushed in the full-open position until the water is clear. The University's Representative will provide the Contractor with the duration of flushing at 2.5 ft/s during the formation of the Disinfection Plan.

E. Critical service disruptions. When emergency eyewashes and/or emergency showers for in-use laboratories are removed from service due to disinfection procedures, alternative emergency eyewashes and showers shall be provided.

F. Procedure for chlorinating the pipeline.

1. Water supplied from a temporary, backflow-protected connection to the existing domestic water system shall flow at a measured rate into the newly installed water pipeline. In the absence of a meter, the rate may be approximated using a Pitot gauge in the discharge, measuring the time to fill a container of known volume, or other approved methods.
2. A service cock shall be installed on piping intended for disinfection for the introduction of hypochlorite solution and for use as a sample bib for testing purposes. Service cock shall be located no more than 10 feet downstream of the supply point for disinfection water.
3. For disinfection of hot water systems, the temperature of the hot water system shall be reduced to that of the cold water system before initiating chlorination.
4. Prior to initiating chlorination, each outlet and valve shall be posted with signs indicating water may not be used; e.g., "Do Not Use", or "Chlorinated Water – Do Not Drink". Postings shall be made in English and Spanish. Water lines shall remain isolated from use, and faucets and valves shall remain posted until conditional or final approval for use has been given by the University's Representative.
5. At a point not more than 10 feet downstream from the beginning of the new pipeline, water entering the new pipeline shall receive a dose of hypochlorite fed at a constant rate such that the water will have not less than 25 mg/L and not more than 35 mg/L free chlorine. To ensure that this concentration is provided, measure chlorine concentration at regular intervals in accordance with the procedures described in the current edition of Standard Methods for the Examination of Water and Wastewater or AWWA Manual M12, or using approved chlorine test kits. The hypochlorite solution may be applied to the water pipeline with a gasoline or electrically powered chemical-feed pump designed for feed chlorine solutions. Feed lines shall be made of material capable of withstanding the corrosion caused by the concentrated chlorine solutions and the maximum pressures that may be created by the pumps. All connections shall be checked for tightness before the solution is applied to the pipeline.
6. All fixtures shall be partially opened to allow for a simultaneous trickle of flow. Chlorine application shall not cease until the entire pipeline is filled with heavily chlorinated water, as verified by measurements at the fixtures. The University's Representative will witness the initial concentrations measured by the Contractor and may take disinfection verification samples to confirm compliance. Following verification of chlorination, each

outlet and valve shall be closed.

7. The chlorinated water shall be retained in the pipeline for at least 24 hours, but not more than 48 hours, unless approved by the University's Representative. At the end of the retention period, the treated water in all portions of the pipelines shall have residual of not less than 10 mg/L of free chlorine.

G. Final Flushing.

1. Clearing the pipeline of heavily chlorinated water. After the application retention period, heavily chlorinated water shall not remain in prolonged contact with the pipe. In order to prevent damage to the pipe lining or to prevent corrosion damage to the pipe itself, the heavily chlorinated water shall be flushed from the main fittings, valves, and branches until chlorine measurements show that the concentration of the water leaving the pipeline is no higher than that generally prevailing in the distribution system or 0.5 ppm. The University's Representative shall take samples and determine the chlorine concentration of the flush water.
2. Disposing of heavily chlorinated water. Flushed water shall not be discharged, either directly or indirectly, into campus storm drainage systems. Flushed water may be discharged into the campus sanitary sewer system if approved by the University Representative, otherwise, the Contractor is responsible for retaining the water on-site and removing and disposing off-site in accordance with applicable regulations.

3.3 DISINFECTION VERIFICATION

A. Sampling. After final flushing and before the new water pipeline is connected to the distribution system, 2 consecutive sets of samples, taken at least 24 hours apart, shall be collected from the new pipeline. Under normal circumstances, the first set of samples will be collected immediately following the final flushing. At a minimum, the University's Representative will take samples every 1,000 feet of pipeline, plus 1 set from the end of the pipeline, and at least 1 set from each branch. The Contractor shall provide dedicated and clean sampling taps at these locations. A corporation cock may be installed in the pipeline with a copper-tube gooseneck assembly. After samples have been collected, the gooseneck assembly may be removed and retained for future use. The number and location of samples from fixtures is at the discretion of the University's Representative and shall be determined on a project-specific basis. The source water will also be sampled. The University will test the samples for bacteriological quality, turbidity, and pH in accordance with Standard Methods for the Examination of Water and Wastewater. For approval by the University's Representative, 2 consecutive sets of samples from each location shall show the absence of coliform organisms and turbidity and pH consistent with that of the source water.

B. Special conditions. Under certain circumstances, such as when excessive quantities of dirt or debris are known to have entered the pipeline, the University's Representative may elect to collect bacteriological samples after allowing the water to stand in the new pipeline for at least 16 hours after final flushing has been completed.

3.4 RE-DISINFECTION

A. If the initial disinfection fails to produce satisfactory bacteriological results, the new pipeline may be re-flushed and resampled. If the check samples also fail to produce acceptable results, the pipeline shall be rechlorinated by the continuous-feed method until satisfactory results are obtained. Re-flushing, resampling, and rechlorination shall be at no expense to the University.

3.5 APPROVAL

A. Conditional Approval. After satisfactory completion of the disinfection procedure, the University's Representative may issue conditional approval for immediate use of the water distribution system pending results of bacteriological analysis of water samples.

B. Final Approval. Upon receipt of laboratory confirmation that all samples are negative for coliform bacteria, the system will be approved for immediate use.

END OF SECTION 33 13 00