DIVISION 33 – UTILITIES

Includes the following sections:

GENERAL UTILITY DESIGN REQUIREMENTS 33 05 00

UTILITY PLANNING

1. The University has conducted master plans of the campus utility systems, consult with the University's Representative for the most current versions and 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 3 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 2 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 3' 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, verify services with the University Representative.
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

Pothole all existing utilities that need to be exposed during construction including; utility crossings, and points of connection, during the design phase and before finalizing the construction documents.

INTERFACE TO BUILDINGS

The main campus is in a rural setting with 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 assure upstream ducts are sealed and penetrations into buildings and equipment are provided with rodent prevention measures such as maximum ¼" wire mesh with foamed sealants at service entrances and adequate consideration for drainage of conduits is provided.

UTIILITY SHUTDOWNS

The need for 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 100% Schematic Design phase. In some cases, a utility shut down 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 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 UCSC Project Manager (PM) to Physical Plant when exactly to secure or reestablish systems when contractors are ready. UCSC PM to relay information from contractors to Physical Plant.

The MOP shall be submitted 30 days prior to the desired date for service interruption. Contractor shall contact UCSC Project Manager (PM) to schedule a project coordination meeting with UCSC Physical Plant with 7 day advance notification of the meeting. Contractor shall submit a shutdown request to the UCSC PM 21 days prior to the desired date for service interruption.

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 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 station and other utility devices ("Utility Devices").

1. The locations of above grade Utility Devices hall be integrated into the building and landscape design concept. Locations shall be coordinated between the Engineers designing the utility and the Landscape Architect or Building Architect 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 above grade Utility Devices shall be indicated on the Design Development site plans.
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 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 (3) foot hard working surface at any required access points.
4. A minimum setback of three (3) 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.
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 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 Owner's review and shall be consistent with current Owner's practices.

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.
2. All nonmetallic pipe shall be laid in the trench with a # 10 bare copper tracer wire laid directly on top of the pipe. The tracer wire shall be attached to the pipe at 10 foot intervals and extended to valve boxes or other locations suitable for attaching pipe locating tools.
3. Underground detectable warning tape shall be installed above all buried utilities approximately 12" 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 (1) warning tape for each twelve (12) inches width of concrete duct bank or 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

The utility meters shall be as listed in table 33. The Standards are intended to provide information about installation specifications for gas, water, and electric meters on the campus. The information is divided into "primary" and "secondary" or sub- metering and other recommendations surrounding separation of usage, as well as criteria for sizing, and products that are used, and connectivity specifications for gas, electric and water meters.

1. At least one meter per utility type shall be provided at each building or structure
2. The following utilities shall be metered separately:
    a. Electricity
    b. Natural Gas
    c. Water – building indoor use, domestic, etc…
    d. Irrigation
    e. Recycled water sources including rainwater, graywater, black water, etc…
    f. Heating hot water
    g. Chilled water
    h. Condensing water
3. Sub-metering shall also be provided for buildings that include areas of mixed use or mixed funding. Some examples include (but are not limited to):
    a. Buildings that contain divided areas with partial state and partial non-state funding

b. Buildings that house an outside vendor in a portion of the building
c. Buildings with a portion of utility usage that needs to be billed to a different account than the rest of the building
d. Buildings with multiple main entry points for a single utility type
e. Buildings that house district-level equipment that consumes energy that should be attributed to other buildings nearby

4. Meter sizing specifications:

   a. For all utilities, the design maximum and estimated minimum usage scenarios shall fall within the accurate measuring capability of the meter installed.
   b. The minimum resolution on any meter shall be able to capture the lowest load condition likely to occur in the building.

5. Manufacturers' product test results, and installed meter calibration reports, are to be submitted with the documentation for all meters.

6. Separate meters shall be installed on emergency equipment.

The campus operates multiple Energy Information Systems and for compatibility of monitoring specific data is trended. Coordinate with the University Representative for identification of the specific systems that metering data is to integrate to using the Meters Trending Points identified.

Metering Trend Points are provided in the table, and represent the minimum metering capability requirements for each utility type:

Utility	Monitoring Points	Recording Interval	Connectivity Specifications
Electric	kW, kWh, Volts, Amps, kVAR, kVA, I ave., Power Factor)	5 minutes	Data connect to BOTH campus SCADA system and campus BMS if on campus; off-campus meters will be networked for communication
Natural Gas	Pressure regulated flow (pressure regulating valve shall be installed directly before meter)	5 minutes	Pulse output OR compatible digital communication and associated hardware shall be installed and connected to campus BMS or SkySpark Server.
Potable Water	Flow, leak detection	Hourly	Shall have data output compatible with the Badger Meters Beacon® Wireless Endpoint. technology
Irrigation			
Heating Hot Water	flow, supply and return temperature	5 minutes	Data connection to campus BMS for point trending via data port, wired output, or other endpoint connection is required.
Chilled Water			
Condensing Water			

PRODUCT PERFORMANCE SPECIFICATIONS & RECOMMENDATIONS

The following table represents a list of products that have been installed and are in use by UCSC. Other products that meet the same performance specifications as those in this list may be used provided they integrate to existing systems and are approved equals.

Utility	Service	Description	Manufacturer	Model(s)
Water	**Notes:**			
	All meters to provide Badger BEACON ORION Cellular Endpoint compatible encoded register with Nicor connector (see ORI-DS-00561 or ORI-UM-00025)			
	All registers to provide readings in Cubic Feet (CF) with a resolution unit of at least 1.0 Cubic Foot (1.0 CF) or better (e.g. Badger E-Series preferred resolution 0.001 CF or 0.01 CF; Sensus OMNI preferred resolution 0.1 CF or 1.0 CF) see LCD-UM-01482			
	Use stainless steel bolts to fit meter with elliptical flange			
	All meters to provide a test port. Use a university approved gate valve and plug on the test port that is the same diameter as the test port.			
	Standard endpoint is CDMA ORION Cellular Endpoint. Use HSPA ORION Cellular Endpoint for areas with low CDMA reception. Inquire with Energy Management Team for signal evaluation.			
	Non-potable building and irrigation water use must be sub-metered so that it can be distinguished from potable water use, and with equivalent accuracy to potable water service.			
	Domestic Residential Industrial	5/8", 3/4", 1" meter and register	Badger	E-Series Ultrasonic Cold Water Stainless Steel Meter
		1-1/2", 2" meter and register	Badger	E-Series Ultrasonic Cold Water Stainless Steel Meter
		>2", indoor meter and register	Badger	M-2000 Series Ultrasonic Cold Water Stainless Steel Meter
		>2", outdoor meter and register	Badger	M-5000 Series Ultrasonic Cold Water Stainless Steel Meter
		ORION Cellular Endpoint	Badger	ORION CDMA or HSPA (see Note 4)
	Irrigation	5/8", 3/4", 1" meter and register	Badger	E-Series Ultrasonic Cold Water Stainless Steel Meter
		1-1/2", 2" meter and register	Badger	E-Series Ultrasonic Cold Water Stainless Steel Meter
		ORION Cellular Endpoint	Badger	ORION CDMA or HSPA (see Note 4)

Utility	Service	Description	Manufacturer	Model(s)
Natural Gas	**Notes:**			
	Circular flanges shall be specified.			
	Natural gas meters shall read in hundred cubic feet (CCF), with a minimum resolution of 1 CCF.			
	Metering specification shall include a dedicated pressure regulating valve installed upstream of the meter.			
	Meters shall be ordered with temperature compensated counters, and partial internal relief (if available).			
	Meters shall specify a low frequency pulse output, or another type of output that can be wired into the campus BMS System (Tridium); all associated labor, material and equipment to safely connect meter to the BMS shall be included in the project scope when replacing or adding gas meters.			
	Meters that require maintenance (i.e. rotary meters w/oil reservoir maintenance...) require bypass piping to be installed as part of project scope.			
	Mechanical, Industrial, Building Main	Larger flow applications (over 800 CF/hr max. flow)	GE Dresser	Dresser ROOTS Meter Series B3
	Residential, Academic, Office, sub- metering	Submetering or low-flow applications (under 800 CF/hr max.)	Esler American	AC-250, AM-250

Utility	Service	Description	Manufacturer	Model(s)
Electric	**Notes:**			
	All building main meters (for existing building meter replacements, or for new buildings) shall be integrated into the campus SCADA Electrical Metering System (ION Enterprise), and to the campus BMS - Tridium Niagara AX Supervisor.			
	The ION meters will have two integral communications ports: one Ethernet port to connect via direct Ethernet to the SCADA system; and one RS-485 twisted pair data port to connect directly to the campus BMS.			
	Only building main meters require a display. All sub-metering shall be connected to the campus BMS, but does not require a display.			
	Building Main Electric service	277V/480V service off the 12kV into the building or sub-section of building	Schneider Electric	ION 8000 series
	Sub-meter - for revenue	Section of building main isolated for re- charging/billing purposes	Schneider Electric, Veris Industries, Inc.	ION 8000 series; Veris H80xx Enercept series
	Sub-meter - for system, equipment, or energy management monitoring purposes	Single panel, distribution panel, circuit, or other load within a building requiring separate kW, kWh trending	Veris Industries, Inc.	Veris H80xx Enercept series
		Multiple circuit branches, equipment assemblies, or panels within one building, in relative proximity to one another.	Veris Industries, Inc.	Veris H8238 Multi-Circuit Monitor

Utility	Service	Description	Manufacturer	Model(s)
Chilled Water, Heating Hot Water, Condensing Water	**Notes:**			
	Building process utility meters shall be included in the scope of all new construction or major modification/renovation projects, along with any associated work necessary to connect and program a meter into the BMS.			
	Metering equipment installed for these systems shall output the necessary parameters to calculate energy consumption (water supply temp., return temp., flow) at 5 minute intervals to the BMS.			
	Flowmeters shall be compatible with modbus, bacnet, or Ion communication protocols.			
	Building HHW, CHW, or CW	Plant production/use, building use, equipment submetering	Flexim	FLUXUS® F704 Energy meter

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

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" diameter. The campus water system has 8 separate pressure zones insolated through 13 pressure reducing valve stations (PRV's). 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 5 locations along Empire Grade. The water points of entry from the city are all backflow protected by reduced pressure principle backflow devices, and metered.

The City's water system serving the campus is composed of an 8" 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 and is at elevation 426'. This reservoir supplies UCSC's 1" 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 elevation 748' and supplies UCSC's 6" Arboretum and 14" Heller Drive turn-outs. SC Reservoir No. 4 is located on the west side of Empire Grade across the ravine to about Kresge Collage. 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' which in turn supplies UCSC's 12" Pump Station and 14" Cave Gulch turn-outs. At the UCSC 12" Pump Station turn-out the University owned pump station pumps water to the University owned Emergency Water Storage Reservoir at elevation 1113'.

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 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.

CAMPUS WATER DISTRIBUTION SYSTEM MASTER PLAN

A master plan for the water distribution system on UCSC's main campus was completed in March 2004 by the Kennedy/Jenks Engineers from Palo Alto, California. This document is available from Physical Planning & Construction and is archived under project number 110009-001. Included in this document was hydraulic capacity modeling of the existing system and also for the projected growth scenario under the 2005 LRDP. The modeling software used was H2ONET.

REFERENCED CODES AND STANDARDS

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

1. California Building Codes, Title 24, parts 1 through 12 as applicable.
2. California Code of Regulation Title's 17 and 22.
3. National Fire Protection Association (NFPA) 13 and 24.
4. These Standards
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 "Campus Engineer, UCSC Physical Planning & Construction" wherever it occurs in the above document.
6. American Water Works Association (AWWA) Standards

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

WATER MAIN SYSTEM EXTENSIONS

Definition; For the purposes of these standards a water main shall be defined as any portion of 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 the Campus Engineer.

Details Required on Plans

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. Plans shall show plan and profile details of 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 type of shutdown required, i.e. routine, large, or major. Valves shall be numbered per University valve numbering system, consult with 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 (POC's) 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 placement of isolation valves and additional hydrants that are specific for developing a flushing sequence.
3. New POC's to existing mains shall be installed with a new T and a valve in each direction to establish a three valve cluster.
4. Provide isolation valves at a maximum spacing of 1000 feet along water mains.
5. Provide combination air / vacuum release valves at all system high points.
6. Provide blow-offs at all system low points.
7. Provide fire hydrants at a maximum spacing of 400 feet along water mains, or as required for compliance with California Fire Code, Appendix C.
8. Provide a water quality sample tap station connected to the system main for each new building complex.
9. Provide a new water PRV Station when a water main will cross a pressure zone elevation boundary or when required to maintain system static pressure below 150 PSI. Water PRV stations shall be equipped with 2 parallel PRV's; one sized to regulate domestic water flow and the other 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 PRV station shall include:
    a. A full size bypass pipe with manual valves parallel to the PRV's.
    b. Two water meters each in series with a PRV. Each water meter
    c. Manual valves upstream and downstream of the PRV's
    d. Concrete pad.

e. Fenced enclosure on all sides and top.
f. 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.

Water Main Sizing

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 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" 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 most recent existing model is converted to the new format. The following system design criteria shall be used in designing the system extension;

- Minimum allowable pressure at peak hour demand: 50 PSI
- Minimum allowable pressure at maximum day with fire flow: 20 PSI
- Maximum allowable service pressure: 150 PSI
- Maximum allowable pipe velocity at maximum day with fire flow: 10 FPS
- 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:
    - 3,000 GPM at no less than 20 PSI during maximum day conditions for Zones 1, 2, 3, and 5.
    - 4,250 GPM (fire flow requirement at the McHenry Library) at no less than 20 PSI during maximum day conditions for Zone 4.
    - 750 GPM sprinkler flow requirement at no less than 50 PSI for Zones 1 and 5 (to ensure 40 PSI minimum at top floor of 2 story building).
    - 750 GPM sprinkler flow requirement at no less than 60 PSI for Zones 2, 3, and 4 (to ensure 40 PSI minimum at top floor of 4 story building).

NEW WATER SERVICE CONNECTIONS

All new service connections shall be requested to and accepted by the Campus Engineer. Provide the following information; use, size, POC, Fixture units, fire flow requirements.

Services shall be fed from looped water mains so that that the likelihood of a building shutdown due to a water main break is minimized. Each structure shall have a dedicated service connection and each service connection shall be metered. Domestic and irrigation water uses shall be individually metered.

Backflow Protection:

A reduced pressure principal back flow 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 Campus Engineer or UCSC EH&S Department.

Service Connections:

Small (2 inch) – Concentric tapping sleeve with 2" resilient seated gate valve and concentric pipe reducer downstream to service size.

Medium (2 inch) –Concentric tapping sleeve with 2" resilient seated gate valve on service at main

Large (>2 inch) – Three valve tee

Fire service line shall be an independent connection that serves the internal fire suppression system of a building.

PRV – due to the significant elevation changes on campus, 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

A. All piping, valves, and appurtenances shall be rated for a 200 PSI minimum working pressure.

B. Acceptable piping materials include:

1. AWWA C-900 PVC Pipe with restrained joints.
2. Ductile iron pipe, cement lined with restrained joints.
3. Type-K Copper Tubing with brazed joints (Underground under 4")

Notes: 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.

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

D. Valves

All water distribution system valves, water supply valves, and fire system supply valves, including valves over 12", shall be rated to a minimum working pressure of 200 PSI. All valves shall open by turning the stem counterclockwise (left). 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 coated. Buried valves shall have stem extensions to place operating nut within 6" of the top of the value box. Valve boxes shall be precast concrete valve boxes with cast iron ring and lid, rated for H 20 loading. Provide eye bolt for valve identification tag within top 3 inches of 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 or mechanical joint as required for the type of pipe and use. Contractor shall provide manufacturer affidavit of compliance per AWWA.

1. All gate valves 3 inch 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 non-rising stem. Gate valves shall be installed vertically in buried, horizontal water lines without

gearing, bypasses, rollers, or tracks. Diameter of stem and number of turns to open shall conform to Table 4 of AWWA Standards C509. Stem seal shall consist of two 0-ring type stem seals in accordance with Section 4.7 of AWWA Standard C509. Bonnet and gland bolts shall be either fabricated from a low alloy steel for corrosion resistance or electroplated with zinc or cadmium. The hot-dip process in accordance with ASTM Designation A 153 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 gear box, designed for buried use.

E. Valve boxes shall be Heavy Traffic rated, precast concrete with cast iron traffic covers. Traffic box shall be circular with the word "WATER" embossed on the top surface.

F. 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 complete assembly

2. Current list of approved manufacturers and models is available from the City of Santa Cruz.

G. Any non-metallic pipe shall be provided with a 10 gauge tracer wire.

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 1 inch. Service connections shall be:

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

*If main line isolation valves are already present nearby, the Campus Engineer 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.

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.

Irrigation water services shall include a PRV, meter and reduced pressure principle backflow prevention device installed outside and above grade.

All tees require three valves and crosses require four valves. A valve may not be required on any leg of a tee or cross if another valve is within 150 feet. Generally, there shall be a maximum of 500 feet of water main between isolation valves in the core campus and 1500 feet in rural areas.

Asbestos Cement 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, see UCSC Standard Drawing -, Asbestos Cement Pipe Undercrossing, or
2. Cement slurry backfill against undisturbed soil to support AC pipe (maximum of 2 feet depth of slurry backfill allowed).

Minimum Cover is the distance from the top of the pipe to final finished grade measured directly over the pipe. For mains, branch, and service connections, the minimum cover shall be 30".

Where cover is less than standard or greater than 7 feet, written approval from the University's Representative is required. Where cover is less than the standard, ductile iron pipe is required.

Mechanical Restraints - Provide 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 installations shall use restrained joint fittings. Thrust blocks shall only be used if connecting to existing unrestrained pipe or fittings and be explicitly shown on the plans, including location and thrust block size. Provisions shall be made to insure that pipe joints, fittings and valves are not covered by the thrust block concrete.

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

EXECUTION

A. Pressure test piping to 200 P.S.I. 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).

B. All Contractor requests for onsite inspections by the campus Fire Marshal to test fire protection systems shall allow for a minimum of two working days' notice.

C. Thrust blocks shall be neatly formed and inspected by Fire Marshal before backfilling. Use building paper between concrete and fittings.

D. Nuts and bolts of mechanical joints shall be coated for corrosion protection.

FIRE SUPPRESSION WATER DISTRIBUTION LATERALS 33 11 19

All work shall be designed in accordance with the requirements of the SCFD/DCFM, the applicable editions of WATER MAIN SYSTEM EXTENSIONS. Coordinate the approval of the SCFD/DCFM and the University's Representative. Coordinate the electrical conduit installation for supervisory systems with the Fire Alarm Division.

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 of the soil (see Soils Report) 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. See Section 21 00 00 Fire Suppression for information on valves and additional requirements.

Vertical piping, piping installed within 5 feet of the building and piping under all footings and slabs shall be cast or ductile iron.

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 deadman of sufficient size to secure the flanged fitting.

Double Detector Check Valve Assembly and Fire Department Connection (FDC):
A double detector check valve assembly is required on all fire lines. Refer to the Campus Standard Detail - Double Check Valve Assembly with FDC Service - for more information

1. Location of this assembly shall be approved by the Campus Architect and Campus Fire Department. Locate the assembly outside of the building in an accessible service area and not in a highly visible location. -
2. Assembly shall be 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 fire department connection shall be clearly visible 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 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 approved by the University Fire Prevention Services.

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 check valve at each fire department connection.
7. Paint the FDC with 2 coats of reflective paint (bright white with a minimum visual light reflectance value of 90%) and provide a building identification sign or pictogram as approved by Fire Prevention Services.

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 shall not be permitted except for Fire Hydrants. Depth of bury for piping shall be a minimum of 36 inches under vehicular paving. Measurement is from the top of the pipe to grade.

When the system riser is close to a foundation or footing, underground fittings of proper length shall be used to avoid pipe joints located in or under the wall or footing. When the connection passes through a foundation or footing below grade, a 1 to 2 inch clearance shall be provided around the pipe, and the clear space filled with asphalt mastic or similar flexible waterproofing material.

INSPECTION & TESTING

Inspections are required by the SCFD/DCFM and University’s Representative. An inspection of 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.

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

SYSTEM OVERVIEW:

UCSC owns and operates the sanitary sewer system that provides service for all buildings on main campus. The 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 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 1960's 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 it is flow is measured by a university owned flume meter 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 following standards.

1. California Building Codes, Title 24, parts 1 through 12 as applicable.
2. California Code of Regulation Title's 17 and 22.
3. These Standards
4. City of Santa Cruz, Department of Public Works, Standard Specifications, Part 2 Technical Provisions.
    a. The term "City Engineer" shall be replaced by "Campus Engineer, UCSC Physical Planning & Construction" wherever it occurs in the above document.
5. City of Santa Cruz, Department of Public Work, Standard Details
    a. The term "City Engineer" shall be replaced by "Campus Engineer, UCSC Physical Planning & Construction" wherever it occurs in the above document.

6. The Greenbook; Standard Specifications for Public Works Construction by Public Works Standards, Inc.
7. 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.

CAMPUS SANITARY SEWER MASTER PLAN;
A master plan for the sanitary sewer system on UCSC's main campus was completed in September 2011 by the Wallace Group Consulting Engineers from San Luis Obispo, California. This document is available from Physical Planning & Construction and is archived under project number 9089. Included in this document was hydraulic capacity modeling of the existing system and for also for the projected growth scenario under the 2005 LRDP. The modeling software used was MWHSoft InfoSWMM Version 9.

SEWER SYSTEM MANAGEMENT PLAN
UCSC is enrolled in the 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. 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 extension shall be designed and stamped by a California Licensed Civil Engineer.

Capacity Modeling: Sanitary sewer capacity modeling shall be included within the design process for those projects were 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", With approval of the Campus Engineer, an exception to use 6" pipe maybe allowed when it can be demonstrated that a run is unlikely to have future additional loads and all other design criteria has been met.
Minimum Pipe Slope (Prescriptive Method); 2%
Pipe Slope (Engineered Method): Based on hydraulic design using the following criteria:

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

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 wherever

Acceptable SS Pipe Materials:	SDR 26 PVC Gravity Sewer Pipe Fusible PVC pipe
Pipe Materials Not allowed:	SDR 35 PVC pipe HDPE Pipe Vitrified Clay Pipe Asbestos Cement Pipe

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

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 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 to existing at existing manholes or by constructing a new manhole over the point of connection.
2. Where an existing sewer main is to be extended, remove the existing plug, cleanout, 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.

Inverted Siphons

1. Inverted siphons shall be used only upon special approval after all other design options have been investigated.
2. The siphon shall be designed with two barrels, with a gate system directing the flow towards either the primary or secondary barrel.
3. Design to achieve a minimum velocity of 3 FPS maintained for several hours a day.
4. Vertical curves shall be used for all change in slope (100 feet minimum).
5. The rising slope of the downstream leg of the siphon shall be limited to 15%.

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.
3. Locator boxes shall be placed at every horizontal change in alignment or a maximum of every 500 feet.
4. Boxes shall conform to valve box requirements per UCSC Standard Detail P-01 with the lids clearly marked, “SEWER.”

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 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 gutter.
4. Vertical curves or bend fittings in gravity sewer mains are not allowed.

Laterals

1. Provide a separate lateral and cleanout or manhole for each building and structure.

2. Cleanouts: Pipe extension to grade with compression type plug. Install curb box over riser pipe. Use precast concrete box Christy F8 with cast iron lid or approved equal in non-traffic areas and Christy G5 with cast iron lid or approved equal in traffic areas. Lids shall be marked "SEWER."
3. Lateral cleanouts shall be installed within 10 feet of the structure.
4. Sewer laterals serving buildings or facilities which 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.

Sanitary Sewer Manholes and Rodding Inlets

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 in excess of 200 feet in length. Rodding inlets may be installed in lieu of manholes at the end of a sewer main where the distance is less than 200 feet to the nearest manhole and the main size is 10 inches or less.
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 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 extra depth of trenching unless unusual circumstances exist. Upstream slope changes shall be used to avoid the need for a drop manhole.
8. When one drop connection is required, use a 60 inches diameter manhole. When two or more drop connections are required, use a 72 inches diameter manhole.

Industrial Waste Discharges

1. Grease traps, grease and sand 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 the appropriate Sewer Standard Plans.
2. Food Service facilities shall have a grease interceptor installed outside the facility in an area accessible for accessible for service vehicles.
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 University. Preventive measures shall be taken to eliminate the intrusion of any rainwater or surface runoff.

4. Wash pad areas shall be diked and/or sloped so that the smallest area possible drains to the sewer.
5. Outdoor sewer connections must be covered to prevent intrusion of rainwater.

Lift Stations

1. Lift stations shall not be allowed where an acceptable alternative gravity route exists.
2. Design the lift station to serve the entire tributary at build-out densities in accordance with sewer system master plan, LRDP and I/I allowances.
3. All pumps, regardless of station type, shall be non-clogging, 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 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 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 minimum 72 inches in diameter with 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. Standpipe connects to 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.
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. Display shall be installed in 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. High level alarm shall enunciate when wet well effluent level is within 24" of top of well. All pumps, motors, internal valves and piping, level indicators, 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.

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 electric, submersible, centrifugal non-clogging units capable of passing a 3-inch sphere. Pump and motor shall be suitable for continuous operation at full name plate 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 pump without the need for the operator to enter the wet well.
4. All hardware in wet well, chains, cables and slide rails shall be 316 stainless steel.

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.
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. If space does not permit isolation valves for each pump use 3-way valves.
4. Main Pump Check Valves shall be cast iron swing checks with externally weighted lever return. Check valve shall not be installed in the vertical. Disc shall be 316 stainless steel or cast iron with bronze trim. 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. 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 Physical Plant, a minimum of 24–inches above the ground. Provide generator receptacle to

match Utility Division standard or stand-by generator. 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 kick starts, 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 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 stand-by power with dedicated standby generator. The generator shall be fueled by natural gas.

CAMPUS STORM WATER UTILITIES 33 40 00

SYSTEM OVERVIEW: The campus's storm drainage conveyance system is comprised of multiple types of engineered storm water detention systems, urban contaminant removal systems, storm water piping, catch basins, surface run-off, and swales that discharge to natural drainage elements including channels which bisect the campus and karst type features. The UCSC campus does not have an interconnected, campus wide, piped storm water 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 storm water conveyance is typically limited to piping immediately around non permeable facilities, such as roads, walkways and structures, as needed to direct flow and avoid damaging improvements before returning storm water back to the natural environment.

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

PIPED STORM WATER SYSTEMS
REFERENCE CODES AND STANDARDS:
Unless otherwise indicated in these standards, all work for the campus storm water utilities shall be designed and installed in accordance with the most recent editions of following standards.

1. California Building Codes, Title 24, parts 1 through 12 as applicable.
2. California Code of Regulation Title's 17 and 22.
3. These Standards
4. City of Santa Cruz, Department of Public Works, Standard Specifications, Part 2 Technical Provisions.
    a. The term "City Engineer" shall be replaced by "Campus Engineer, UCSC Physical Planning & Construction" wherever it occurs in the above document.
5. City of Santa Cruz, Department of Public Work, Standard Details
    a. The term "City Engineer" shall be replaced by "Campus Engineer, UCSC Physical Planning & Construction" wherever it occurs in the above document.
6. State of California, Department of Transportation, Highway Design Manual, Chapters 800 – 890 Highway Drainage Design.
    a. Where the terms "State" or the "Engineer" are used in the State Specifications, they shall be considered as meaning "UCSC" or "Campus Enginer, UC Santa Cruz Physical Planning & Construction."
7. State of California, Department of Transportation, Standard Specifications, Section 10 through 98; more specifically, Division VII Drainage Facilities
    a. Where the terms "State" or the "Engineer" are used in the State Specifications, they shall be considered as meaning "UCSC" or "Campus Enginer, UC Santa Cruz Physical Planning & Construction."
8. State of California, Department of Transportation, Standard Plans; more specifically the Drainage sheets, no D71 through no. D102
    a. Where the terms "State" or the "Engineer" are used in the State Specifications, they shall be considered as meaning "UCSC" or "Campus Enginer, UC Santa Cruz Physical Planning & Construction."

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, and Section 33 05 26, Utility Line Signs, Markers, and Flags

CAMPUS STORM WATER AND DRAINAGE MASTER PLAN

A master plan for storm water and drainage on UCSC's main campus was updated in September 2004 by Kennedy/Jenks Consultants from Santa Clara, California in association with Balance Hydrologics from Santa Cruz, California. This document is available from Physical Planning & Construction and is archived under project number 11009-005.

DEFINITIONS / ABBREVIATIONS:

Reserved

DESIGN QUALIFICATIONS:

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

DESIGN REQUIREMENTS – STORM WATER 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.

B. Ensure that storm water meets water quality 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 Campus Engineer to determine scope details. All outfall facilities shall be upgraded as necessary to comply with current best practice and these standards; at a minimum, extend piped systems to toe of 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 surface are required to comply with UCSC Post-Construction Requirements as outlined below.

B. All projects that create and/or replace ≥ 500sf < 2500sf of impervious surface must implement at least the following design strategies throughout the Project site (a storm water memo documenting compliance must be provided at 100% Design Development):

    1. Limit disturbance of natural drainage features

2. Minimize compaction of highly permeable soils
3. Limit clearing and grading of native vegetation at the site to the minimum area needed to build the project, allow access, and provide fire protection
4. Minimize impervious surfaces by concentrating improvements on the least-sensitive portions of the site, while leaving the remaining land in a natural undisturbed state
5. Minimize stormwater runoff by implementing one or more of the following site design measures:
    a. Direct roof runoff into cisterns or rain barrels for reuse
    b. Direct roof runoff onto vegetated areas safely away from building foundations and footings, consistent with California building code
    c. Direct runoff from sidewalks, walkways, and/or patios onto vegetated areas safely away from building foundations and footings, consistent with California building code
    d. Direct runoff from driveways and/or uncovered parking lots onto vegetated areas safely away from building foundations and footings, consistent with California building code
    e. Construct bike lanes, driveways, uncovered parking lots, sidewalks, walkways, and patios with permeable surfaces.

C. For all projects that create and/or replace ≥ 2500sf of impervious surface see Campus Standards Appendix C for 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 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 storm water. Direct connections from depressed loading docks (truck wells) to storm drains are prohibited. Refer to Division 33 Utilities for details.

C. All storm water 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 capable of holding a minimum of 50 gallons.

D. Provide a quick-coupler, or, if attached to a building, a restricted access hose bib to prevent illicit discharge to storm drain system

E. Dumpster areas shall be designed with storm water run-on 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, area must be covered to prevent storm water from entering sanitary sewer and bermed to prevent runon and runoff.

H. Food facility outdoor wash areas for cleaning of equipment and accessories must be connected to an oil and grease interceptor before discharge into the sanitary sewer.

I. Provide drain to landscape in bottom of utility boxes and vaults. Discharged water shall not enter a storm drain.

J. Fire sprinkler inspector test must flow to sanitary sewer

K. All interior floor drains must drain to sanitary sewer

L. Elevator sumps may not discharge to storm drain system or daylight

M. Outdoor materials storage areas shall be designed to prevent storm water 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 storm water.

DESIGN REQUIREMENTS – STORM WATER 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 area.

B. Provide positive surface drainage away from buildings, 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 is 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 storm water management; 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 storm water facilities to accommodate a 10 year storm event at a minimum.

    1. Minimum Pipe Size is 8”.

    2. With approval of the Campus Engineer, an exception to use 6” pipe may be allowed when it is technically infeasible to use 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, 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 to be minimum 24" wide to allow cleanout, unless approved otherwise.

3. Manholes shall be constructed with eccentric cones.

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.

6. All new storm drain inlets and catch basins to be labeled to indicate prohibition of illegal discharge. Coordinate with University Representative.

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.

H. Underground storm drainage collection and disposal systems shall be designed to provide a minimum flow velocity of 3.0 fps when flowing ½ full.

Storm Drain Pipe Materials

1. Acceptable Pipe Materials:

    a. PLASTIC
        i. SDR 26 PVC Gravity Sewer Pipe
        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 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 water tight per Section 61-2.01D(2)(a), note that no field testing is required unless 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 application with University Representative and campus engineering

2. Pipe Materials Not allowed: SDR 35 PVC pipe
Vitrified Clay Pipe
Asbestos Cement Pipe

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 sewers 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 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 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 labelling 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

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 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 psig system. New services connected to 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- 54.

B. Provide a gas regulator (provide 7" w.c. or higher pressure depending on the equipment needs. (e.g. emergency generator) and meter at each new building (See Division 22 00 00 for above grade piping requirements and Division 33 05 33 for gas meter requirements).

C. 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 the Principal Engineer for UCSC Physical Planning and Construction. Improvements to the campus system may be required to accommodate the additional demand.

The Principal Engineer shall identify a suitable point of connection to the campus system and what system improvements may be necessary to accommodate the new building.

D. Each new building service shall have a seismically activated earthquake shutoff valve.

E. New service for standby and emergency generators shall be independently regulated, metered, and NOT have a seismically activated shutoff valve.

F. Qualifications- 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 standard detail 2.6-12, 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, Rockwell or equal). Valves shall have 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 detail; 2.6-2, Gas Branch Main and Valve Installation)

D. Provide each valve with a valve box and extension to final grade. Valve boxes shall be pre-cast concrete with a triangular cast iron traffic cover marked "GAS". (Brooks 4-TT 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 reading in cubic feet of gas per hour and provided shall be provided for the following building classifications. Meters shall be bellows type by Singer or American.

1. Academic Buildings
2. Housing
3. Food Service
4. Other areas as determined for specific projects.

MINIMUM DESIGN REQUIREMENTS

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

METERING

The natural gas meter shall be installed at service connection to the building in an accessible location. Meter shall be capable of local and remote read-out. See Division 22 00 00 for more information. Also refer to Division 33 05 33 Utilities Meters for BMS requirements for summation of meter pulse output.

Meters shall be preceded by an isolation cock on the anodeless riser, a replaceable filter assembly, and regulator. Refer to the Campus Standard Specification Section 33 51 00 Campus Natural Gas Distribution System.

STEEL PIPE

Pipe

Black steel, Schedule 40 with X-Trucoat, Greenline, or equal, factory wrap on buried lines.

Fittings

1. Buried: Steel butt-welding or socket welding type
2. Above Ground: Welded, or malleable iron threaded.

Valves

1. Underground: Valves under three inches shall be threaded and made up with threaded nipples, in a vise, before inserting into the line by welding. Valves three inches and larger shall be generally flanged and attached to slip-on welding flanges.
2. Lubricated plug cock: 1 inch and larger, Rockwell 115, Walworth, or equal. Provide lubricated plug cock for all below grade applications. Extend lubrication port and valve handle to a minimum of 6 inches below grade in valve box.
3. Corporation stops of dissimilar metal shall not be used.

Unions

1. Underground: Unions shall not be used.
2. Above ground: Flanged or threaded metal-to-metal shall be used.
3. Dielectric (insulated) unions shall be installed at designated points for cathodic protection.
4. Regulators and meters shall be protected from damage.

Corrosion Control

In order to provide protection of 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. Above grade piping shall be painted Safety Yellow.

1. 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 assure 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.
    d. Plastic coated pipe, prime area to be wrapped plus a minimum length of 4 inches from the cutback edge.

e. 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 assure 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 to 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 pipe, extended 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 use 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 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 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 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, prior to installation in trench. Coordinate test with University's Representative for witnessing. At least 48 hrs. 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 pipeline:

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 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 to other underground structures.
3. Provide heat damage protection from other underground facilities such as steam or electric power lines. This is especially critical for cathodically protected pipeline, which shall be isolated from underground foreign piping.

PLASTIC PIPE

Polyethylene gas piping is preferred over steel pipe. 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) may also 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 main connections, a protective sleeve designed for the specific type of connection shall be used to reduce stress concentrations. All main connections shall be composed of a three valve cluster.
3. At 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 anticipate 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 Standards Trenching Detail.
9. Service lateral to each meter: Extend racer 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 use.
2. Each imperfection or damage that would impair the serviceability of plastic pipe shall be removed or repaired by a patching saddle.

3. The patch or sleeve material shall be the same type and grade and wall thickness shall be at least equal to that of the pipe. The sleeve shall extend at least 1/2 inch beyond the damaged area. The joint line between the halves shall be as far as possible from the defect.
4. Each plastic pipe joint shall be made in accordance with manufacturer's recommendations using the proper type equipment required for the type of joint required. Plastic pipe may not be joined by a threaded joint or miter joint.

Installation of Pipe in a Ditch.
For mains, a minimum covering of 30 inches

1. 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.
2. Inspect condition of ditch bottom just before pipe is lowered in.
3. Plastic pipe shall be laid on undisturbed soil, well compacted soil, well tamped soil, or other continuous support. Blocking shall not be used to support pipe.
4. Piping shall be installed with sufficient slack to provide for possible contraction.
5. Piping shall be installed with enough clearance to allow proper maintenance and to protect against damage that might result from proximity to other structures.
6. 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
Designed 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.
4. Use rigid pipe casing fastened to the valve. Casing pieces 2 feet long will usually provide stabilization.
5. Use a metallic pipe sleeve rigidly connected to the valve and encasing the plastic.

Cathodic Protection of Isolated Steel components in Plastic piping systems
Provide one of the following (confer with Physical Plant Plumbing Shop for their preference prior to design):

1. A small galvanic anode directly connected to the steel component.

2. Each steel component may be connected to a locator wire which is also connected to one or more galvanic anodes. To facilitate monitoring, the locator wire may be terminated at one or more service risers.
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 University's Standard Drawing - Gas Valve and Valve Box.

TESTING (steel and plastic)
Mains shall be pressure tested at a minimum of 100 psi, for a minimum time of 4 hours. Service lines shall be pressure tested at a minimum of 50 psi, for a minimum time of 4 hours.

CAMPUS DISTRICT COOLING WATER SYSTEM 33 62 00

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. Chilled water system butterfly valves shall be flanged or mechanical joint type and shall be of the rubber seat type. Valve discs shall rotate 90 degrees from the full open position to the tight 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. 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 coated with asphalt varnish.

Branch Connections (chilled water) - All connections to the chilled 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 chilled water system, install an additional butterfly valve and abandon tapping valve in place (in open position).

CAMPUS DISTRICT HEATING WATER SYSTEM 33 63 00

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 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 from 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 20 PSI differential at a point roughly two thirds through the district loop. DP feedback signal is located at McHenry Library Basement Mechanical Room (there is also an alternative back-up DP signal 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 primary return water temperature at a constant 140 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.

C. New Core Academic Buildings: The district heating water system shall be used as the primary heat source for space heating and hot water for all new academic buildings constructed in the campus core. 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 22 00 00 for water heater requirements.

b. Space heating for small buildings with space heating loads 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 by the Principal Engineer for Physical Planning and Construction. 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 secondary heating water systems.
   b. Ground Water Protection: Below grade piping, vaults, and manholes shall be designed to prevent the intrusion of ground 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 trench watertight. Provide a gravity drain or a sump pump at each vault and manhole.

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. 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 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 exchanges shall be rated for 300 psi primary/secondary pressure differential.
   c. Color Coding: Primary heating water piping inside buildings shall be color coded red and labeled for flow direction.
   d. 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 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 following design provision as it may have changed: Provide DDC sequence of operation to control primary heating water return to a constant set point of 140 degrees.
   e. 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, instantaneous energy use rate (BTU/Hr). Totaled energy use (BTU's). Refer to Division 33 05 33 for BTU meter requirements.
   f. 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 design flow rate while verifying that the 2 way automatic control valve is full open, and that the pressure differential at the system mains is being controlled to constant 20 PSI by the campus energy management system.
   g. 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 pipe volume of the laterals to the building, as well as the pipe volume within the building.

Oversize the building expansion tank to provide for a minimum future increase in system pipe volume of 20 percent.

h. 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 high hazard 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.

i. Water Treatment: For buildings with primary / secondary pumping through a de-coupler bridge, a water treatment chemical pot feeder is not required for the building heating water system. Chemical treatment will be provided from the Central Heat Plant via the system mains.

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 per cent. Design flow rate shall be based on the assumption of an 80 degree Fahrenheit temperature differential between primary heating water supply and return. Pressure differential at the system mains shall be assumed to be 20 PSI for buildings above Kerr Hall. For Buildings below Kerr Hall, assume a pressure differential of 15 PSI at the system mains.
   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 per cent.
   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 T fittings or weld-o-lets. Penetration of the existing pipe wall shall be drilled, sawcut, or ground followed by reaming, so as to produce a smooth surface with minimal flow

restriction. Use of cutting torches to penetrate the existing pipe walls will not be allowed. Within the contract documents (division 1) call out 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 Physical Plant with a minimum 14 days advance notice.

e. Provide manual isolation valves 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 drainage provisions or sump pump 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 sawcutting, (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 systems pipe mains whenever possible. Where this is not practical, calculate the expected expansion of the main and provide a connection design which 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 into the top of 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.

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. Outer conduit system shall be sealed water tight. Outer conduit shall be continued through pipe penetrations of concrete walls with concentric space being sealed water tight by mechanical seals. Provide provisions to accommodate pipe expansion either by expansion loops or specially manufactured

elbows. Provide 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 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 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 225 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 manufacturer's directions.
   d. For buried conduit system piping, all testing shall also be in accordance with manufacturer's directions. Consult with the University Representative shall 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. Inner carrier pipe shall be Type K copper tubing with a factory supplied O-ring coupling system. 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 minimum 1 inch thick closed cell polyurethane foam. 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. O-ring coupling systems will be allowed to accommodate pipe expansion only when other alternatives are not practical, and shall be approved by the University's Representative. Such systems shall not be placed under any concrete slabs, and shall be recorded on as-built drawings. Provide 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 VOLTS

UNIVERSITY 21KV SUBSTATION AND PRIMARY 12KV SUBSTATION
The University is currently served by PG&E at 21KV entering the campus at Slug Station. Two 21KV feeders are routed from Slug Substation (Slug-Sub) 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.

UNIVERSITY 12KV SWITCH/SUB STATIONS
Switch stations are constructed with multiple circuit breakers and capable of distributing 2000 to 3000 amps at 12KV to feeders and substations distributed throughout the campus. The individual substations provide a second level of protection to the main substation, enable selective coordinate through high speed protection relays, and reduce the areas of the campus that would be affected by a local outage. The switch station protection consists of relays that can detect; out of phase, overcurrent, phase to phase and ground fault. 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.

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.

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. Shall new feeders be proposed the line ups would need to be expanded and new sections required. In this case testing, commissioning, integration and relay settings to new fault current and coordination study would be required. All campus 21KV and 12KV cabling shall be designed per Campus Design Standards. Where there are references to 12KV versus 12.47KV the campus system operates at 12KV. There is no voltage regulation on the system and PG&E maintains voltage to 5% 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 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 status of all the protection relays. The protection relays are

designed have layers where instruments with very specific design properties overlap and back each other up.

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, not 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. Selection of PT/CT ratios (typically 600:5) and use of correct ANSI class devices is 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/sub stations 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 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 on 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 that 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 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.

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 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 in the lower and west sides of campus that are not on the campus 12kv grid.

A limiting factor on design of 12 kv infrastructure is sizing of building transformers. Calculated demands in larger facilities can result in transformers that will not coordinate with the distribution system overcurrent protection scheme and careful consideration of distribution system settings is required to retain selective coordination on the system. The design professional shall request the University Representative to provide the trip curves for the feeder breakers that protect the feeders the buildings are served from, and to design the system to enable selective coordination for ieee device numbers 50/51 and 50/51N, confirm requirements with the University Representative. This generally means 12 kv transformers with smaller then 80E fuses will coordinate, anything larger will require relay equipped pad-mount sectionalizing switches, or unit substations to enable coordination with the campus utility feeders.

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 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 21 kv service. This consideration could result in 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 no kirk-key interlocks are 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 an additional multi-way pad mounted switches or circuit breaker, depending on the size, to feed individual transformers, ie 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. See 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. Study shall be prepared and signed by a California registered Electrical Engineer. Submit studies to University's Representative prior to receiving final acceptance of distribution equipment shop drawings or prior to release of equipment for manufacturer. If formal completion of studies may cause delay in equipment manufacture, acceptance from University's Representative may be obtained for preliminary submittal of sufficient study data to ensure that selection of device ratings and characteristics shall be satisfactory. Provide for both normal and emergency systems.
2. Studies shall include all portions of electrical distribution system from the point of connection, primary of service transformers down to and including 480V and 208V distribution system. Normal system connections and those which result in maximum fault condition shall be adequately covered in the study.
3. Study report shall summarize results of system study 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 scope of study.
    b. Tabulations of 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.
4. Protective Device Testing, Calibration and Adjustment: 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.
2. All pole top construction shall be tri-mount with king pin, per PG&E standards.
3. All guys shall use insulating rod (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 convenient location to facilitate fault location.
10. Surge arresters shall be used on trunk or backbone feeders during the transition from overhead to underground. The lighting arrester shall be installed on the riser when determined necessary.

ELECTRICAL UNDERGROUND DUCTS AND MANHOLES 33 71 19

Electrical Duct - All 12KV electrical power ducts shall be constructed with concrete encasement and with minimum 30-inch cover to top of concrete. Concrete encased raceway shall be PVC schedule 40 duct and end bells. Elbows shall be factory made, use 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 3 inch minimum separation between runs. Provide plastic spacers at maximum 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 red oxide per yard of concrete. All ducts shall drain to a manhole or pull box. All underground conduits and ducts 2 inches and larger shall be proven clear by pulling through a mandrel 0.25 inches smaller than the inside diameter. 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 H20-44 wheel loading. Provide knockouts for future duct connections.

Electrical manholes shall be an octagon design. 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 daylight if practical. Where not practical provide the manhole with powered sump pump located in an unused corner and for manholes without a powered sump pump, locate sumps in the center. Sumps shall not discharge to storm drain system.

Pulling irons shall be installed on the wall opposite of each duct line entrance. 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" in the top of 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 opening for manhole hook accessibility.

Medium Voltage Pull Box - 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" in the top of cover.

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 water tight, submersible in each Manhole, from 6 inches below the Manhole ceiling to the bottom of the Manhole.

Where used, 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 used, Load Transformer Service Units - 480/240/120 V, 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, 10/2, 480 volt. Secondary connection to three 15/1 circuit breakers in a junction box. Secondary panel board consisting of four 15/1 circuit breakers, 120 volt. Transformer secondary midpoint grounded to the local ground cable. NEMA 1A general purpose enclosure.

Miscellaneous Devices

1. Auxiliary Wiring: Code type XHHW stranded copper No. 12 AWG minimum, except for cord to sump pump motor. Cord for sump pump furnished with sump pump.

2. Terminal Blocks: Provide a 3 point (circuit) 3 tier (tier common) assembly for No. 10 and No. 12 conductors. Bottom 2 tiers for No. 10 conductors, top tier for No. 12 conductors. Unit shall be Cage Clamp type for 2 conductors each side of terminal as manufactured by WAGO Corp., T&B Corp., or equal.
3. Boxes: Cast Aluminum or steel with bolt-fastened cast gasketed covers.
4. Raceway in Manholes: Rigid galvanized steel conduit with threaded watertight couplings and connectors.
5. 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 Copper
   b. All other Larger Cables: Copper
2. Insulation: 15KV Class, MV105, 133% BIL rated EPR jacket.
3. Stranded Shield: Extruded semi-conducting Ethylene Propylene Rubber (EPR).
4. Shield: Extruded semi-conducting EPR, in void free contact with the extruded insulation.
5. Fault indicators shall be current reset type capable of automatically being reset when line current is restored. Fault indicators shall be capable to interface with up to 12 magnetic interface probes that communicate via wireless to a remote fault reader.
6. Shield Drain shall be spiral wrapped copper tape, 0.005 inch thick min. Wrap half lapped shall not exceed 25 percent.
7. Encapsulating Jacket: Extruded HMW-PE, CPE or PVC outer jacket enclosing the cable assembly.
8. Conductor rating shall be 105 degree C normal, 140 degree C emergency, 250 degree C short circuit conditions operating temperatures. 133% insulation level.
9. 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.
10. Install #2 bare copper grounding wire between manholes.

CABLE CONNECTIONS

Provide Elastimold non-load break or equal. 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 and non-separable splices 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, Elastomold 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 (Non-Load Break). Provide capacitance test point. Connectors shall satisfy 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
High Potential Tests
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 that 5 uniform steps up to the maximum test voltage. The minimum time at each step shall be no less than required for 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 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 8-1/2 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 operator performing test
   c. Name of company operator is employed by
   d. Section of cable tested
   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-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 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 the University's Representative with a record of all insulation resistance measurements.

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 transformers (PG&E UG-1).

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	95 kV, minimum
Secondary BIL	30kV, minimum

Primary Connection
Loop feed, 6 200 amp universal busing wells.

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). In cases where the switch serves as a LOOP feed 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 Bay-O-Net. 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 external 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 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 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. Color shall be Munsell No. 7GY3.29/1.5 Green.

Latches
Three Point Manhole Style.

Grounding Pads

Steel ground pad welded to tank wall in primary and secondary compartment. 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.

Testing

Field testing requirements for oil filled transformers to 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/FA 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	10 kV
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 constructed on a steel channel base arranged for four point mounting only. The unit provided complete with vibration isolating mountings. The units each furnished complete with required anchor bolts.

Primary Service Cable - Shielded copper cable entering vertical 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 over-current protection of 12 kV underground feeders and for remote manual switching of a circuit. Unit shall be controlled with electronic control panel included with the assembly, and 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 over current 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 coordinate with distribution system, see Distribution System Protection Relaying and consult with the University Representative for integration into the campus distribution grid.

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

1. Ratings:

Operating Voltage	Continuous Current	Interrupting Current	Momentary Current	Control Voltage
12KV	200	12,000A	6,000 (min)	20 ac

2. Vacuum Interrupter: The Interrupter unit 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 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 form 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. Remote Manual Control: Provide a remote trip and close push button control station for each interrupter as follows:
   a. Two-unit Pilot Light Station indicating Interrupter OPEN and Interrupter CLOSED.
   b. Two unit Push Button Station for interrupter TRIP and interrupter CLOSE.

6. Automatic Control: Provide the following functions, all field setable:
   a. Phase over current, inverse time trip - 200 amps.
   b. Ground over current, inverse time trip - 50 amps.
   c. Inrush restraint on phase and ground trips.
   d. Provide indication of cause of trip.
7. Primary Connections: Universal bushing wells, 200 amp, each with a parking stand.
8. Vacuum Circuit Switching Unit: 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.
9. Low voltage closing solenoid to be installed to provide contact closing energy.
10. Universal Bushing Wells: Compatible with all industry standard plug inserts for load break and non-load break separable UD cable connectors rated for 200 amp, 15 kV service. Recloser to be supplied with the following bushing arrangement: 200 amp wells load and source.
11. Low Voltage Closing: Include equipment for internal operation of low voltage DC closing solenoid and associated wiring.
12. Auxiliary Switch: For remote indication of recloser contact position or switching. Three stage switch to be mounted on the recloser frame.
13. Bushing Type Current Transformer: Multi ratio current transformers to be factory installed on load side bushings. Primary/secondary current ratios of 600:5 to be provided. Secondary taps to be factory wired to terminal blocks on the control panel.
14. Control Cable: As required for sensing and control between 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.
15. 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	15 kV, 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	35 kV
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 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 weather proof cabinet with hinged, captive bolt fastened door, with provision for padlocking closed. Finish coat of epoxy enamel.

Remote Manual Control Station

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 Tite pendant type Control Station. Each station two unit, each unit two position momentary contact, depress to close, in 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 to provide not less than 2 inch concrete penetration.

PADMOUNT MEDIUM VOLTAGE SWITCH AND VACUUM INTERUPTOR 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 ANSI/IEEE 386 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.
4. Switch shall have 24 vdc linear actuator for opening and closing.

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, leak detection test. 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.

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. & loadbreak, 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 independent of the operating lever if closing into a faulted or heavily loaded phase or circuit. Interruption or reset shall be three phase.

Electronic Control

1. Draw out over-current relays shall be provided to sense load and fault current on each phase of the load tap circuits. Relays shall be powered by a capacitor trip devices powered by a fused potential transformer mounted inside the oil-insulated switch tank. No external power source shall be required.
2. The relays shall monitor the load or fault current on the individual phases of the tap circuits using input from the current transformers.
3. All tripping shall be three phase. Temperature range shall be –40 degrees C to +85 degrees C.
4. Manual tripping shall be provided.

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. Enclosures shall be filled with transformer oil.
3. The enclosure shall be provided with four lifting eyes that provide a balanced lift for the complete assembly.
4. 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. Oil fill port.
2. Four lifting provisions.
3. Welded entrance bushings.
4. Oil level gauge.
5. Grounding provisions for one 1/2-inch – 13 ground connection per switch way plus provisions for one 1/2-inch – 13 tank ground connections.
6. Three-line diagram and stainless steel nameplate, permanently mounted.
7. Stainless steel tank and lids, stainless steel and brass fasteners, with no external aluminum parts.
8. Tank coating to be light gray (ASA 70) paint with primer, 3-mil-thick minimum.
9. Pad-lockable operating mechanism with position indication.
10. Phase designation nameplates.

11. 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 factory. The University will furnish records of previous factory test results.
3. Contact resistance test across each switch blade.
4. Operation test of all switch and vacuum interrupters.

MEDIUM VOLTAGE LOAD BREAK SWITCHES (SECTIONALIZING SWITCHES)
Three phase 600 amp, 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. Automatic Control - Provide the following functions, all field setable:
    a. Phase over-current, 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 over-current, 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 horizontal on the support frame, the support frame mounted on the wall of the manhole.
    a. Cable Connections - Apparatus Bushing for separable connector, 600-amp. Cable to be trained and tied in such 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 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. Retractile Cord - Install with cord grip connectors to the Pilot Light Station and to the Control Station.
    c. Control Wiring - Run in rigid steel conduit, except for the retractile cord between the pilot light station and the push button control station.

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 be 3 or 4-way type, and each way shall be 3-pole, 2-position, "on-off" 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 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

Field Testing of Medium Voltage Interrupters - 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 padmount switches) conducted at 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.

The following field tests will be performed by the University's Representative.

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

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 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 beveled washer each side.

TESTING

Grounding test shall be by fall-of potential method by a NETA certified 3rd party testing agency.

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 University Facilities Management 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, 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, properly labeled and painted.

E. Provide documentation that all fire hydrants have been flow tested and accepted by the University Fire Department.

F. Field verify that all fire hydrants are set to grade, properly labeled 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 per Section 33 12 13.13 Backflow Preventers. 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. Contractor shall submit a written utility activation request at least 5 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. 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 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 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 University Utility staff to review the Commissioning Checklist.

B. Field verify that the interim “As Builts” are correct, that the sewer system was installed per contract, 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 television 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 5 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 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, 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 location for disposal of flushing water.

B. Following completion of disinfection, provide a Disinfection Certification Report confirming compliance with specification 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. 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 assure 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, fitting, and valves shall be protected from contamination. Pipe delivered for construction shall be strung to minimize the entrance of foreign material. All opening 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 requirement specified in other sections of specification.

D. Sealing materials. No contaminated material or any material capable of supporting 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 piping requirement specified in other sections of specification.

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 1 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 a location to discharge flushing water during 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 the duration of flushing at 2.5 ft/s during 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 method.

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", "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 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 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 Contractor is responsible to retain the water on site, remove and dispose 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 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 REDISINFECTION

A. If the initial disinfection fails to produce satisfactory bacteriological results, the new pipeline may be reflushed 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. Reflushing, 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 a 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