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General

Welcome

The Facilities Design Standard (FDS) is a collaboration between UW Facilities and various campus Process Partners, and it is intended for use by design, construction, and maintenance professionals to facilitate the design, construction, and maintenance of University facilities and assets. These standards represent proven systems that are based on life cycle cost analysis, and provide functional facilities and systems that satisfy the University's Best Practice requirements for efficient operation and maintenance.

These design standards and standard specifications are to be adhered to and incorporated into all project and maintenance contracts, for all types of contract delivery methods. Any deviations to these standards shall be vetted through a documented resolution process, prior to the completion of project design documents or maintenance contracts.

FDS Organization and Use

Each FDS section contains Design and Standard Drawing concepts; standard specifications are included when a specific system and/or product is preferred because of spare parts inventories, prior experiences of the University, staff training on sophisticated equipment and/or to match existing systems, just to name a few. Standard Detail Drawings are intended to be used as shown or with slight modifications, modifications should be reviewed with the University Representative or Engineering Services prior to implementing. Implementation of the FDS is a collaborative process where flexibility, openness, and forward thinking are encouraged.

FDS Disclaimer

These standards are not intended to replace codes, other design standards, the services of a professional design team, or professional design analyses. Consultants shall conduct their own independent evaluations and are liable for the final design. This document is copyrighted by the University of Washington. Use of this document for University of Washington official business is permitted, contact Engineering Services to request approval for any other purposes. Do not reproduce any part of this document that contains the University name or logo.

Sustainability

The University of Washington is a leader in sustainability and committed to implementing best practices through environmentally responsible construction for every new building and major capital renovation, projects greater than $5M. The UW Green Building Standard was established and following performance requirements were developed for the facilities.

- LEED Gold certified is the minimum target using the most current LEED standard.
- Design to reduce energy use with a minimum threshold of 15% more efficient than local city code.
- Using current code as a baseline, design to achieve at least 50% reduction for indoor and outdoor potable water use.
- Additional energy performance criteria can be found under the Energy Conservation and other discipline sections of the Design Standard.

The University is committed to sustainability at a leadership and policy level as stated in the following -

- Climate Action Plan, 2009
- Executive Order No.13, 2012
- Campus Master Plan, 2019
- Sustainability Action Plan 2020
- STARS Reporting Ongoing *(developed by the national Association for the Advancement of Sustainability in Higher Education)*

The State of Washington established greenhouse gas (GHG) emission reduction goals for state agencies and requires GHG reduction by 15% from 2005 levels by 2020; and reduction by 45% from 2005 levels by 2030. The University also participates in, or is a member of a variety of organizations. Please refer to the following website for more information: https://green.uw.edu/dashboard/awards, which design should take into consideration. For more information about what organizations' designs should be in alignment, please contact UW Sustainability (sustainability@uw.edu), or a University Representative.

Record Drawings

The University maintains a record drawing system, the Facilities Information Library (F.I.L.), that documents the overall utilities, as-built drawings of the individual systems, and building connection points, just to name a few. This record drawing library can be accessed online, and access to this system is granted through the UW Project Manager for the duration of individual projects. The website has many helpful how-to documents, including a document contained in Section G4 of the online help system within F.I.L. that has hyperlinks to the most common and the most up-to-date record drawings.

Engineering Services can assist with navigation of F.I.L. once full access is granted. Contact the UW PM for access rights to the drawings needed.

Utility Locates

All projects are to include drawing and specification notes to indicate that the Contractor shall notify the Utility Notification Center (811) at least two (2) to ten (10) full working days before digging. Note that the University maintains records online for designers to research the University utility system at their leisure and generally from their office. This is intended to limit the use of the 811 system for design purposes. See the "record drawings" section for an explanation of this system and how to gain access.

Coordination

The Design Standard has been organized by discipline and responsible department in an effort to aid the Design Professionals with implementing the University's performance criteria into the project. There may be times where the information one is seeking is not in an area you might suspect - please review all sections.

Closeout Documents

At the end of a project ensure that the documents on the Project Closeout Documents Checklist are submitted within one month of substantial completion.

Organization of the UW Design Standard

Facilities

- Engineering Services working with Central Utilities and Operations
    - Civil
    - Architectural
    - Structural
    - Mechanical
    - Electrical
    - Conveyance
    - Tunnels
    - CAD and BIM Standards
- Building Maintenance Services
- Campus Automated Access System CAAMS
- Space Guidelines
- Sustainability
- Exterior Improvements
- Transportation

Additional University Design Standards

1. Academic Technologies Audiovisual Systems Integration
2. Classroom Support Services design guide
3. Environmental Health & Safety Facility design guides (including fire safety, lab safety, safe access, environmental protection, hazardous materials, and more)

4. Police Department Risk Mitigation & Security Services
5. Emergency classroom locking devices (ECLD)
6. UW-IT Design Guide

UW Locations

1. Bothell
2. Tacoma

Revision History

Design Information

1. Facilities Design Information 1970
2. Facilities Design Information 2007
3. Facilities Services Design Guide 2012-2018
4. Facilities Design Standard 2020

Requirements Common to All Disciplines

A. Equity

1. **Accessibility and ADA Compliance**

   Contact Engineering Services Architect

2. **IT Accessibility**

3. **Gender Neutral**

   Contact Engineering Services Architect

B. Coordination

The following are some common examples of coordination needs on a project. Please note that this list is not exhaustive, and Design and Construction Professionals shall evaluate what types of coordination may be needed on a project during the design and construction phases.

1. **Architectural with All Trades:** e.g. envelope details and repair/replacement strategy; curtain walls containing electrical / mechanical equipment; provide base line for the City of Seattle (COS) Building Tune-Up Ordinance
2. **Structural with All Trades:** e.g.: penetrations of structural components by other trades; fall protection; roof hoist for buildings without elevators; equipment ramps for curbs on roofs
3. **Civil and Mechanical:** e.g.: backwater valve required due to height of next upstream manhole; point of connection elevations for water, storm and fire protection testing
4. **Civil and Electrical:** e.g.: exterior gravity drainage for site features that may transmit water into a building or downstream devices
5. **Mechanical and Electrical:** e.g. short-circuit current ampacity rating of mechanical equipment; sizing of transformers serving devices commanded to start at the same time by building automation system; specialty fire protection systems; harmonic mitigation for systems with vfds; floor drainage/protection for electrical rooms that may be compromised by mechanical system leakage; permanent wiring labeling; metering system accuracy from field device to the Smart Metering cloud
6. **Internet of Things (IOT):** Record all systems that collect data. Evaluate: storage location; data collection devices; storage amount required; responsible party for maintenance.

C. Preferred Vendor List

The latest technologies generate numerous options, many levels of sophistication and life cycle limitations. In order to predict service expectations for equipment and continuing education, Engineering Services has summarized a Sole-Sourced or Limited-Sourced list. Refer to the sections below.

Civil

Architectural

Mechanical

Electrical

Environmental Health & Safety

D. On Which Systems Must You Train Us?

The following are some common examples of coordination needs on a project. Please note that this list is not exhaustive, and Design and Construction Professionals shall evaluate what types of coordination may be needed on a project during the design and construction phases.

1. Worker Safety

a. Access for equipment above fixed equipment/furniture **–** demonstrate with equipment used for installation.
b. Contractor Lockout Tagout Procedures
c. Removal of large or heavy equipment through designed pathways.
d. Sampling of structural design elements – e.g. removal of rooftop membrane and heavy equipment mounted on the roof; fall protection pull test; fall protection means for future PV installations.

2. Equipment

a. Demonstrate equipment location as-builts – fire dampers; room lighting controllers; critical BAS sensors
b. Demonstrate baseline Building Tune-Up verification.
c. Building Automation System
d. Lighting Control System

E. What We Expect for System Redundancies

1. Research Buildings

a. Redundant mechanical and electrical equipment
b. Redundant sources to meet UW lockout / tagout requirements

2. **Classroom / Office Buildings**
   a. Ability to meet mechanical and electrical programming needs for each department.
   b. Redundant sources to meet UW lockout / tagout requirements

Preferred Vendors and Products - Architectural

Product	Manufacturer A	Manufacturer B	Manufacturer C	Manufacturer D	Remarks
Masonry Repair Anchors	Helifix	Blok-Lok	Simpson Strong Tie		No Substitutions / Or approved equal for helical stainless steel anchor only.
Wedge anchors	Heckman				No Substitutions / Or approved equal for galvanized steel wedge anchor only.
Wall Ties	Dur-O-Wall	Homann & Barnard			No Substitutions / Or approved equal for adjustible, two-piece, stainless steel anchor only.
Flexable Flashing	W. R. Grace	Henry			No Substitutions / Or approved equal for self-adhesive sheet flashing only.
Damp Proofing	Sonoborne	Karnak	W. R. Meadows, Inc.		Or approved equal.
Sealers	ProSoCo				No Substitutions / Or approved equal for solvent-borne siloxane sealer only.
Sheathing	Densglas				Or approved equal.
Water Barrier	Henry				Or approved equal.
Torch Applied Built-Up Roofing	Siplast	Durbigum			No Substitutions / Or approved equal for mod bit roofing only
Cover Board	USG Securock				No Substitutions / Or approved equal for cement roof board only.
Membrane, Liquid	Hydrotech 6125	Carlisle CCW-500R	American Permaquik		No Substitutions / Or approved equal for hot rubberized asphalt only.
Membrane, Sheet	CETCO Voltex DS				No Substitutions / Or approved equal for self bonding bentonite only.
Damp Proofing	W. R. Grace	Meadows	Karnak		Or approved equal.
Sealers	ProSoCo				Or approved equal.
45, 60 & 90 Minute Doors	Algoma Hardwoods	Eggers Industries	Vancouver Door	VTI Industries	No Substitutions
Cylinders	Medeco				No substitutions
Butts	Stanley	McKinney			Or approved equal.
Electric Transfer Hinge	Von Duprin				Or approved equal.
Key Switch	Von Duprin				Or approved equal.
Exit Device	Von Duprin	Corbin			No Substitutions
Locksets & Latches	Corbin	Schlage	Medeco		No Substitutions
Closers	LCN				No Substitutions
Closer 180^{o}	Norton				No Substitutions
Astragal	Pemko				Or approved equal.
Door Stops	Glen Johnson				Or approved equal.
Push/Pull	Builders Brass				Or approved equal.
Kickplates	Builders Brass				Or approved equal.
Thresholds & Weatherstripping	Pemko				Or approved equal.
Door Operators (ADA)	Record Doors				No Substitutions
Auto-Door Sensors (ADA)	B. E. A.				No Substitutions
Door Actuator (ADA)	Largo				Or approved equal.
Door Position Switch (CAAMS)	Sentrol				Or approved equal.
Door Holders	Rixon				Or approved equal.

Preferred Vendors and Products - Architectural

Product	Manufacturer A	Manufacturer B	Manufacturer C	Manufacturer D	Remarks
Floor Leveling Compoound	Ardex				Or approved equal.
Fire Extinguisher	Amerex	J. L. Industries	Larsen		No Substitutions
FE Cabinet	J. L. Industries	Larsen			No Substitutions
CAAMS Micro Control Panel	Casi-Rusco				No Substitutions
Input/Output Modules	Casi-Rusco				No Substitutions
Card Reader	Casi-Rusco				No Substitutions
Power Supply	Alarm-Saf				Or approved equal.
CAAMS Contractor/GE/UTC Picture Perfect	RFI Electronics				No Substitutions
Keys	Chicago Lock				No Substitutions
Governor	Hollister - Whitney				No Substitutions
Car Exhaust Fan	Nylube				Or approved equal.
Operating Panel	EPCO				No Substitutions
Telephone Cabinet	Ramtel Corp. (model RR733-942M)				No Substitutions
Intercom	J. Phillips LLC				Or approved equal.
Emergency Car Lighting	Nylube (mod EL-SS)				No Substitutions
Alarm Bell	Nylube (model ELB-6)				No Substitutions
Solid-State Power Supply	Motion Control E.S.				No Substitutions
Harmonic Filter	Myron Zucker Co				Or approved equal.
(Electric Traction Elev) Solid State Power Supply and Logic Control	I-Box Motion Control engineering System 12	CEC/Swift Futura	O.Thompson Ultra 2000		No Substitutions
(Hydraulic Elevators) Solid State Logic Control	Motion Control E.S. PHC 1000	O. Thompson Microflight Series 90 2000-H			No Substitutions
Hall Buttons	EPCO				No Substitutions
Car Direction Lantern & Sound Signals	C. E. Electronics				No Substitutions
Hall Direction Lantern & Sound Signals	C. E. Electronics				No Substitutions
Door Hangers and Tracks	MAC	GAL			Or approved equal.
Door Operators	MAC	GAL			Or approved equal.
Door Edge Protective Device	Janus Elev Products				Or approved equal.
Hoistway Access Switch	EPCO				No Substitutions
Custodial hardware	Bobrick				

Preferred Vendors and Products - Electrical

Product	Manufacturer A	Manufacturer B	Manufacturer C	Manufacturer D	Remarks
CMCS system	Allen Bradley PLC-based	Allen Bradley IAS			No substitutions
generators 175kw and larger	Caterpillar				No substitutions
generators smaller than 175kw	Caterpillar	Onan	Kohler		Or approved equal.
transformers	ABB	Square D	GE	Siemens	Or approved equal.
TV monitor and camera backbox	Steel City #H2-BD-3/4 1 and #2-GC				Or approved equal.
MV connections & terminations	Raychem HVT	3M Quick Term series 5600			Or approved equal.
Splices other than cold shrink	OZ Gedney Series SPKJR	G&W #E74	Adalet 3AS (PLM)		Or approved equal.
MV connections & terminations	3M	Elastimold			Or approved equal.
Approved manufacturers	ASCO-Delta	Russelectric	Cutler Hammer		Or approved equal.
Power circuit breaker	Cutler Hammer Vacuum Breakers (VCP-W) no exceptions				No substitutions
Electrical Vaults	Utility VaultCo	Renton Concrete Products	Fog-tite	Quasizte	Or approved equal.
Primary Switch	S & C				No substitutions
Transformers	ABB	Square D	GE	Siemens	Or approved equal.
Local Data Collection Controller	See Standard Specifications				No substitutions
Service Meter	See Standard Specifications				No substitutions
Sub-Meter	See Standard Specifications				No substitutions
SCADA - Multi-Channel Isolated Digital I/O Modbus TCP Module	Advantech e.g. ADAM-6050				No substitutions
test block	GE type PK-2 #6422120G3; type PK-2 #6422420G4	Marathon 1500	Buss #15149-3		No substitutions
Switchboards	GE	Siemens	Cutler Hammer		Or approved equal.
Network Relays	Electronic Technology Inc (ETI)	Cutler Hammer MPCV	Other manufacturers shall be approved during the design phase		No substitutions
Breakers	GE MicroVersaTrip PM	CH OPTIM 1050	or approved equal		Or approved equal.

Preferred Vendors and Products - Electrical

Product	Manufacturer A	Manufacturer B	Manufacturer C	Manufacturer D	Remarks
Panelboards	CH	GE	Siemens		Or approved equal.
cabinet locks	Corbin TEU-1	GE 75			Or approved equal.
Transfer switches - for UW Class E1 & E2 emergency services	Russoelectric				No substitutions
Transfer switches - for UW Class E3 & E4 emergency services & outlying campuses	Russoelectric				No substitutions
Features and Accessories part #	18 specific Russelectric Items				No Subsitutions
Switchboards	CH	GE	Siemens		Or approved equal.
					See FSDG Section 15G in "Mechanical" sheet.
Switching Systems					No Subsitutions
Centralized	Creston	Douglas	Lutron		No Subsitutions
Clocks	Simplex cat# 6310-9231				No substitutions
Bells	Simplex cat# 2902-9501 buzzers				No substitutions
Intercom	3M	Pamex	Valcom		Or approved equal.
Nurse call systems	shall match existing and / or approved by UWMC ops & maintenance				No substitutions
Paging	TOA	Dukane			Or approved equal.
Room Control System	AMX				Or approved equal.
audio mixers / ampliers	TOA 900 preferred by classroom services				Or approved equal.
Electrical Engineering Firm for Power System Studies	Power Systems Engineering	Siemens Technical Services	Washington Group International, Inc.	Electrotest Inc.	Or approved equal.
Software for short circuit study	SKM Power Tools for Windows				No substitutions
Software for coordination study	SKM Power Tools for Windows				No substitutions
Electrical Testing Contractor	Siemens Technical Services	Sigma 6	Electrotest, Inc.		Or approved equal.

Preferred Vendors and Products - Mechanical

Product	Manufacturer A	Manufacturer B	Manufacturer C	Remarks
CCW Coils & Heat Exchangers	Delta P Valves			No substitutions
Bypass Relief Valve	Cash Acme	Kunkel		Or approved equal.
Freeze Protection	Dowtherm HD			Or approved equal.
CCW valves	TYCO, Vanessa	Weir, Trientric	QUADAX VALVES Inc.	No substitutions
Steam Valves	TYCO, Vanessa	Weir, Trientric	QUADAX VALVES Inc.	No substitutions
VFDs	Allen Bradeley Powerflex 70	Danfoss VLT 20X	Yaskawa GPD 506	No substitutions
Steam Condensate	See Standard Specifications			No substitutions
CCW BTU	See Standard Specifications			No substitutions
CCW Chilled Water Insertion	See Standard Specifications			No substitutions
Deduct Water - Cooling Tower, Grey Water	See Standard Specifications			No substitutions
Deduct Water - Irrigation	See Standard Specifications			
Natural Gas - Main Utility, 2" and Larger	See Standard Specifications			
Natural Gas - Main Utility, up to 1.5"	See Standard Specifications			No substitutions
Natural Gas - Submeter	See Standard Specifications			No substitutions
Water Treatment Controller	Nalco 3DTRASAR			No substitutions
DDC control	Siemens Landis Division	Johnson Controls (Bothell)	Alerton by ATS Automation	Sole sourced/No substitution.
Wall sensors mounting hardware	Allen	Bristol		Or approved equal.
Actuated dampers	American Warming and Ventilation	Ruskin	Greenheck	Or approved equal.
Refrigeration Leak Detection - Control Pnl	Honeywell 301EM control panel			No substitutions
Refrigeration Leak Detection - Control Pnl	Honeywell 301EMRP-20 remote pnl			No substitutions
Refrigeration Leak Detection - Sensor	Honeywell 301IRFS gas detector			No substitutions
Gas Monitors - CO and NO2 sensors for Park	Honeywell E3Point			No substitutions

Preferred Vendors and Products - Exterior Improvements

Product	Manufacturer A	Manufacturer B	Manufacturer C	Remarks
Central Control system	Rainmaster			No substitutions
Controllers	Rainmaster			No substitutions
Controller enclosure Exterior	Strongbox			Or approved equal.
Controller enclosure Interior	PWM			Or approved equal.
Pressure reducing Valves	Watts	Febco		Or approved equal.
Double check valve assembly	Febco	Watts		Or approved equal.
Reduced pressure backflow preventor	Watts			Or approved equal.
Master Valve	Superior			No substitutions
Flow sensors	Rainmaster	Badger/Data Industrial		Or approved equal.
Sub-meters	Sensus accuMag			No substitutions
Zone valves	RainBird			No substitutions
Ball Valves	KBI			Or approved equal.
Pop-Up spray, stream spray, bubbler sprinklers	Rainmaster			No substitutions
Short range sprinklers	Hunter	Toro	MP	Or approved equal.
Medium Range Sprinklers	Hunter	MP	Toro 300	Or approved equal.
Long range sprinklers	Hunter			Or approved equal.
Alternate water delivery	DRIWATER			Or approved equal.
Swing joints 1/2" - 3/4"	Hunter w/ marlex			Or approved equal.
Swing joints 1"	Lasco			Or approved equal.
Quick coupler valves swing joint	Dura			Or approved equal.
Drip Zone filters	Amiad			Or approved equal.
Drip Line	Toro	dripline/microline		Or approved equal.
Air relief valve	AVP			Or approved equal.
Flush Valve	Toro			Or approved equal.
Temp tree driplines	Buckner	Toro		Or approved equal.
Check valves	Hunter			Or approved equal.
In-Line PRV	Rainbird			Or approved equal.
Quick coupler valves	Buckner	Rainbird		Or approved equal.
Shielded flow sensor cable	Rainmaster	Houston Wire		Or approved equal.
Splice Kit	3M			Or approved equal.
Filters, dedicated zone	Amiad			Or approved equal.
Filters, Primary	Amiad			Or approved equal.
Valve Boxes	Carson			Or approved equal.
Drain Valves	RainBird			Or approved equal.
Fire hydrant	Kennedy Model K81A	Mueller Super Centurion 250	Waterous Pacer	No substitutions
Exterior below grade pipe penetrations	Link-Seals			Or approved equal.
Stormwater treatment rechargeable, media-filled cartridges	Contech Engineered Solutions			
Exterior below grade pipe penetrations	Link-Seals			Or approved equal.
Exterior below grade pipe penetrations	Link-Seals			Or approved equal.

Preferred Vendors and Products - EH&S

Product	Manufacturer A	Manufacturer B	Manufacturer C	Manufacturer D	Remarks
Fire Extinguisher	Amerex	J. L. Industries	Larsen		No Substitutions
FE Cabinet	J. L. Industries	Larsen			No Substitutions
Fire Alarm Control Panel (Seattle, Bothell, and Tacoma Campuses)	Simplex 4100U/4100ES				Sole source/No substitutions.
Cabinet locks	Lock & Corbin Cat. #30 Key				No Substitutions
Dry Pipe Valve, size 2-1/2" through 6"	TYCO DPV-1				No Substitutions
Pre-Action Deluge Valve, size 1-1/2" through 8"	TYCO DV-5				No Substitutions
Cabinet locks	Lock & Corbin Cat. #30 Key				No Substitutions
Class II Type A-2	Baker SterilGARDe series	Labconco Logic Series	Nu-Aire LabGard and CellGard Series	Thermo Scientific 1300 series	No substitutions
Class II Type B-1	Baker models NCB-D Series	Nu-Aire NU-427 Series			No Substitutions
Class II Type B-2	Baker BiochemGARDe series	Nu-Aire NU-430 Series			No substitutions
Conventional Flow	Kewaunee Supreme Air	Labconco Protector models	Mott Sigma Pro		No Substitutions
Low Flow	Kewaunee Supreme Air LV	Labconco Xstream			No Substitutions

Civil

A. General

1. Campus Overview / History

The University of Washington Seattle campus covers approximately 640 acres with about 240 buildings owned by the University. There is a total elevation change of 215 feet from edge of shoreline to the highest elevation. Approximately half the campus borders on Lake Washington / Portage Bay while the other half connects directly to City of Seattle owned streets. The utilities serving the University must provide for a wide range of space usage including offices, acid waste, wet labs, athletic facilities, kitchens and medical facilities.

The campus grounds were turned over to the University after the closing of the Alaska / Yukon Pacific Exposition (A.Y.P.E.) which ended in 1909. The new University grounds included three permanent and some twelve temporary buildings from the Expo along with the overall rough grading of the property.

Completion of the channel on the south edge of campus, now known as the Montlake Cut, was completed in 1916 connecting Lake Washington to Lake Union, dropping the water surface in Lake Washington to its present level, permanently defining the border between the campus and the surrounding bodies of water.

2. Public and Private Property

The Seattle main campus is owned by the State of Washington and as such, is public property. No street right of way exists on campus, only the right of way defining the boundary between University and City of Seattle owned land. Most of the utilities on the campus are owned and operated by the University. A few non-University owned utilities exist on campus but there are almost no easements defining their location.

3. Montlake Landfill

The eastern third of the Seattle campus is an old City landfill which has been closed since 1966. This landfill (some 70 feet deep in places) is constructed over a thick peat mat and is capped with a clay soil. The landfill and underlying peat is a constant source of methane and leachate. Construction in this area, and within a 1000-foot buffer, is monitored by the Montlake Landfill Committee (MLC). The MLC meets on a regular basis, or as needed, to comment on the unique requirements for construction proposed in this area of campus.

4. Utility Locates

All projects are to include drawing and specification notes to indicate that the Contractor shall notify the Utility Notification Center (811) at least two full working days before digging. Note that the University maintains records online for designers to research the University utility system at their leisure and generally from their office. This is intended to limit the use of the 811 system for design purposes. See the "record drawings" section for an explanation of this system and how to gain access.

5. **Record Drawings**

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Engineering Services can assist with navigation through F.I.L. Full access is required prior to getting help with using the system. Contact the UW PM for access rights first. Request full access to all drawings.

B. Surveying

This section applies to design standards and procedures involved in the field location and plotting of all-natural objects and surface improvements. This section also includes the requirements for submittal of plans and files to the University.

1. The surveyor is to provide Engineering Services (ES) an AutoCAD copy of any topographic surveys created as soon as they are available. ES will only use these surveys to assist in design development and coordination within the campus grounds. Email them to the ES Civil Engineer.
2. All topographic surveys must be stamped by a Professional Surveyor licensed in the State of Washington.

   The Seattle location is mostly contained within:
   Horizontal Datum used: **NAD 83/91**
   Vertical Datum used: **NAVD 88**

3. On the survey, note any University control monuments encountered. These monuments are designated by a unique number as shown on record drawing 915-C-09. Monuments with numbers in the 500's are new and will not appear on the record.

4. **Mapping**

   a. Preferred mapping scale is 1 inch to 20 feet. Symbol size should be computed based on this scale. Contour interval shall be 1 foot; 2 feet is allowable on steep slopes for clarity of the drawings.
   b. "Hard" surface (i.e. pavement, concrete) spot elevations shall be 0.01' accuracy. "Soft" surface (i.e. grass, dirt) spot elevations shall be 0.1' accuracy. "Soft" surface (i.e. grass, dirt) spot elevations shall be 0.1' accuracy.
   c. Include all ground floor elevations of existing buildings and slab structures within the survey. Verify and show all storm and sanitary sewer inlet and outlet invert elevations at manholes by field measurement as well as rim elevations. Show all underground utilities.
   d. Provide a note on the survey which clearly states all assumptions and limitations in the survey.

e. Identify all buildings shown wholly or partially on the finished drawings by name and accented by shading or crosshatching. When feasible include at least two points upon the building face as far apart as practical. These points will assist the University in locating and rotating floor plans onto the campus map.
f. Field-locate all trees and major vegetation and record location on the map. Identify tree size, type and ID tag numbers on the map. Note the actual canopy of the tree. (Protect existing shrubs, trees and lawn areas during the progress of fieldwork; under no circumstances will their removal be permitted.) Canopies are to be drawn to scale. Do not use one symbol of one size for all trees within the survey unless preapproved by ES.
g. Locate all tunnels and tunnel manholes. Show floor and ceiling elevations of tunnels where applicable.
h. Include a general vicinity map, small scale, on the finished drawings.
i. Use abbreviations as shown in City of Seattle standard plan 002.

5. **AutoCAD**

a. All CAD files that are final versions are to be purged of unused blocks, layers, line-types, etc. All externally referenced drawings are to be inserted into the drawing (bond) and any special fonts included on the CD. Under no circumstance should the CAD drawing modify the "standard" styles. All modified styles should have a unique name.
b. For CAD files include the exact limits of the survey. Providing the triangulated irregular network (TIN) boundary as a closed polyline will satisfy this requirement. This line work should be turned off and not plotted on the paper copy. This will be used by the University to "cookie cutter" surveys into the campus master base map.
c. For legibility, avoid using the "simplex" font in any AutoCAD drawings.
d. Provide all non-standard fonts with each AutoCAD file.
e. To assist in the coordination of projects during the design development phase, email a curtesy copy of the Topographic Survey (AutoCAD Version) to:

James Morin PE
UW Engineering Services
morinj@uw.edu

Official, signed versions are still to be submitted as part of the project closing documents.

6. **Topographic Map, Drafting**

a. Drafting and layout standards.
b. All lettering on drawings shall be 1/8-inch minimum height at final plot scale.
c. Major callouts such as building names, street names, elevations, and dimensions require use of single-stroke vertical Gothic lettering.
d. All lettering to be clear and uniform in appearance and line density.
e. Use Leroy or other lettering devices where applicable, but in no instances place lettering, either pencil or ink, over or through any prior notes, callouts, or legends.
f. Diazo sepia, sepia mylar, slicks, or sticky back on mylar are not acceptable.
g. Provide a ½ inch border on the top, bottom and right side of the sheet.
h. Provide a 1-inch binding edge on the left side of the sheet.

i. Preferred sheet sizes for the University of Washington Facility Management Office standard sizes. Typical sheet sizes to trim lines are as follows:

18”x24”
30”x42”
36”x48”

j. Do not provide sheet size larger than 36" x 48”.
k. Provide identical size for all sheet sizes for any given survey.
l. Surveyors shall consult with the Architect/ Engineer project consultants to ensure that the topographic drawings will be the same size as the design drawings.

C. Earthwork / Grading

This section applies to the design and installation of earthwork and backfill.

1. No stockpiling of excavation materials is allowed unless the Geotechnical Engineer provides inspection services to assure compliance with their recommendations as to the use and stockpiling of the excavation material. Submit report from Geotechnical Engineer to Engineering Services prior to material placement that verifies compliance with Geotechnical recommendations. All stockpile locations and covering measures shall be included in the Temporary Erosion Control plan.
2. No native material may be used in landscaped areas up to sub-grade and no closer than three feet from the building. Discuss this with Geotechnical Engineer and Engineering Services for approval.
3. No recycled material is allowed without coordination with Engineering Services.
4. Identify shoring constraints in the construction documents. For example, “provide a shoring design, or specify vertical shoring, where a sloped excavation would undermine existing structures, utilities, or pavement.”
5. All excavation and backfill work shall conform to the following codes, regulations and standards:

   a. WSDOT-APWA Standard Specifications for Road, Bridge and Municipal Construction, most current edition (not including Measurement and Payment provisions)
   b. City of Seattle Supplement to the Specification for Road, Bridge and Municipal Construction, most current addition.
   c. ASTM Test method D1557 modified for density of soils

6. **All excavated material shall be treated in the following ways:**

   a. Removed from campus at no cost to the University
   b. Used for wall backfill outside 18 inches measured from the face of foundation wall
   c. Used in landscape areas to subgrade
   d. Follow the recommendations of the Geotechnical Engineer

7. Backfill for walls: The first 18 inches behind any wall shall meet City of Seattle Supplement Requirement for Mineral Aggregate Type 17. The remaining backfill behind the wall can be either excavated material or Mineral Aggregate Type 17 as in City of Seattle Supplement.
8. Backfill for utility trenches shall be per City of Seattle specifications.
9. For final grading the designer shall pay close attention to preventing pools of water in hardscape areas. Limits grades to a minimum of 1.5% unless approved by Engineering Services.

10. For landscape planters consider the travel path for runoff and excess irrigation water across pedestrian and vehicle areas and provide area drains or gravel French drains.
11. DO NOT use round rock in any areas exposed to foot traffic, mowers or grass edgers.
12. Grading coordination between Civil and Landscape (if separate contracts) is essential to prevent standing water.

D. Roadways

This section applies to the design and construction of roadways.

1. Fire service is provided to the University by the Seattle Fire Department. Emergency access roads should conform to the Seattle Fire Code Article 9, SFD Administrative Rules, and referenced standards. See drawing 901RU-02 for University Campus Map Fire Lanes and Fire Hydrants.
2. The University road system is designed with student safety as the main concern. When designing new or modifying existing roadways; pedestrian movement, sight distance, speed and conflict points should be considered to maximize pedestrian safety and visibility.
3. Cross walks crossing Stevens Way and Memorial Way shall be made with a 10-foot wide, 12-inch thick, dark grey colored concrete and scored with 2' x 2' square pattern or preapproved pattern.
4. Stevens Way, Memorial Way and Pend Oreille Road are subject to Metro Bus traffic and are to be designed with pavement sections that can handle such traffic. Typically, this is 10-inch concrete over 6-inch crushed surfacing base course section panels.
5. Vehicular PCC paving shall be used in service areas, loading docks, and access roads leading to loading docks, and shall have a minimum thickness of 8 inches over 4 inches of Crushed Surfacing Base Course. Additional pavement section may be needed as a result of the traffic and wheel loading study.
6. Vehicular Asphalt paving shall be a minimum of 3 inches Asphalt Concrete HMA Cl ½" over 6 inches if Crushed Surfacing Top Course. Additional pavement section may be needed as the result of the traffic and wheel load study.
7. Vehicular PCC and Asphalt paving shall meet latest requirements of Washington State Department of Transportation Standard Specifications for Road, Bridge, and Municipal Construction (WSDOT).
8. Provide a flexural strength of a least 3,000 psi at final strength for concrete for vehicular PCC paving. Use high-early cement when it is necessary to open the area to traffic after seven days of curing.
9. Provide concrete for PCC paving with a silica fume additive when (a) the slope of the paving exceeds a 6 percent grade or (b) within 60 feet of a stop sign.
10. The University of Washington shall retain a testing lab to monitor and test all rock, concrete and asphalt samples and check the density of the subgrade before placing the surfacing materials.
11. The specifications shall call for testing of the concrete for vehicular paving to be in accordance with ASTM C 78 Standard Testing Method for Flexural Strength of Concrete (using a simple beam with third point loading)
12. After edging, apply a medium broom finish transversely to vehicular PCC paving.
13. Saw cut joints as soon as possible (approximately 8 to 10 hours after pouring).
14. For long sections of vehicular PCC paving, a test sample showing final surface texture shall be made available at the site prior to initial pour. University Staff shall inspect the test sample. The

Construction Coordinator shall make inspection arrangements with the Contractor and University Staff.

E. Curb

This section applies to the details and placement of curbing. The University prefers the use of cast-in-place concrete curb along roadways and barrier curb within parking areas. The use of extruded curb is limited. Coordinate with Engineering Services on all proposed curb types and locations.

1. Place curbing between all pedestrian traffic and vehicle traffic. Place concrete curb and gutter between all roadway surfaces and sidewalks, and between all roadways and planting areas.
2. In general, surface runoff should not be directed to flow along the toe of extruded curb.
3. Rolled curb may not be used unless approved by Engineering Services.
4. In limited areas extruded curb may be allowed to separate traffic from pedestrians. Coordinate with Engineering Services.
5. It is encouraged to include extruded curb along the back edge of sidewalk to prevent sluffing of material from slopes on to the sidewalk. Coordinate with Engineering Services.
6. Provide concrete curbs with a minimum compressive strength of 3,000 psi at 28 days.
7. See City of Seattle Standard detail 410 and 411 for cast-in-place and doweled curb.
8. See City of Seattle Standard detail 412 for extruded curb.
9. See University Detail SD-C-67 for Barrier Curb.

F. Sidewalk

This section applies to the design and construction of sidewalks, curbs and ramps.

1. Sidewalks at the University of Washington are used by pedestrians, lifts and trucks. Pavement / Concrete sections must be designed to accommodate these loads.
2. Sidewalks can be constructed using concrete or asphalt. Concrete Sidewalks shall be Class 5 (1-1/2") with a minimum thickness of 4 inches over 3 inches of Crushed Surfacing Base Course. Surface texturing, joint details and joint layout shall be in accordance with Standard Plan 420.
3. Asphaltic Concrete Sidewalks shall be HMA Cl ½", with a minimum thickness of 3 inches over 4 inches of Crushed Surfacing Base Course. Use tack coat between all concrete surfaces and new asphaltic concrete. Place tack coat on the surface between all joints to concrete or other asphaltic concrete.
4. For ADA ramps use the City of Seattle standard plan 422 using **WHITE** detectable warning areas instead of "City of Seattle Safety Yellow".
5. The University of Washington shall retain a testing lab to verify sub grade compaction, slump, and strength of concrete, etc.
6. After edging the PCC sidewalk, brush it with a fiber hair brush in a transverse direction.
7. Cure the PCC sidewalk by an approved liquid curing compound.
8. Permeable Pavement
    a. In general, the use of permeable asphalt is only allowed for parking areas that are temporary (Less than 10 years)
    b. Permeable concrete must follow the latest ACI specifications.
    c. Evaluate the following when considering the use of Permeable Concrete:

d. The cost of long-term maintenance
e. The limitations in re-striping in the future
f. The need for special equipment to clean and deep clean
g. The dangers of landscapers stockpiling soils on the pavement and plugging it
h. The inability to plow for snow removal
i. The special requirements for storm structures and grates

G. Parking

Transportation Services (206) 221-3701

H. Utilities

This section applies to the storm water conveyance system.

1. The University storm water conveyance system was originally constructed when the City of Seattle was a combined sewer/storm system. Approximately 20% of the Seattle Campus is still a combined system. Refer to University record drawing 805RU-02 for the complete layout of the storm water conveyance system.
2. For safety and operations, avoid the use of ANY round aggregate for applications that are open to the surface and can be walked on, mowed or edged.
3. Provide engineering calculations used to size all conveyance piping.
4. Do not propose to pump storm water without prior consent from Engineering Services.
5. Provide a manhole, full-sized clean-out, or catch basin at changes in pipe direction or diameter.
6. Install clean-outs at all proposed connections to buildings.
7. Backfill around storm structures with CDF.
8. Use thru curb inlets at low spots in roadway profiles.
9. Do not downsize pipe diameters. Match crown elevations in structures as much as feasible.
10. Storm structures in landscape areas and hill sides not collecting water, should have solid lids with rim elevations 6-inchs higher than the final uphill grade.
11. Drains and cleanouts in grass areas shall be built low so that mowers will not strike them.
    a. Provide structure numbering on the plans.
    b. Provide narrative of downstream conveyance system 500 feet from site.
12. All products, materials, and equipment shall conform to WSDOT/APWA Standards.
13. Piping: SDR 35 PVC pipe per ASTM D3034 for sizes 12 inches in diameter and below, and reinforced concrete pipe per ASTM 67 for sizes above 12 inches in diameter. Exception: Use ductile iron pipe, or ductile iron sleeve, where high surface loads exist, under roadways, and where minimum cover cannot be achieved.
14. Pipe connections: Use fittings made of the same material as the connecting pipe. Use an appropriate adapter when changing materials (e.g. when penetrating a concrete manhole with a PVC pipe).
15. Exterior below grade pipe penetrations: Link-Seals, or approved substitution
16. Refer to following City of Seattle (COS) Standard Plans:
    a. Catch Basin (COS 240a); install inlet pipe invert at least 6 inches above outlet pipe invert.

   b. Catch Basin (COS 242); install inlet pipe invert at least 6 inches above outlet pipe invert.
   c. Catch Basin and Inlet Installation (COS 260b)
   d. Catch Basin and Inlet Installation (COS 260a)
   e. Typical Catch Basin Connection (COS 261)
   f. Inlet (COS 252)
   g. Inlet (COS 250)

17. Inlet Frame (COS 262)
18. Inlet Frame (COS 263)
19. Inlet Frame & Grate (COS 264)
20. Manhole (COS 201a)
21. Drop Connection (COS 233)
22. 8" Clean-out (COS 280)
23. Typical Trench Section (COS 284)
24. Pipe Bedding (COS 285)

I. Water Quality / Onsite Stormwater Management (OSM)

This section covers the design and selection of water quality / onsite stormwater management facilities.

1. All cost analysis should include the cost of land used or parking units displaced.

Cost

2. WQ and OSM facilities shall be selected based on the complete life cycle cost to the University. This cost shall include all maintenance, servicing and replacement over 50 years.
3. Selection and design of WQ and OSM shall be to minimize maintenance impacts to the University.

Access

4. Maintenance access to facilities shall be evaluated for each proposed facility. This will include such items as push mower access, access to service storm structures, gardener safety, and the dangers of using weed trimmers on small aggregates.
5. Structures within the facility need to be located for ease of service.

Design

6. Cleanouts are needed to maintain all conveyance pipes.
7. Maximum slope for wet, mowable surfaces is 4:1.
8. Locate access/inspection/cleanout openings to underground facilities in areas with no traffic or parking conflicts.
9. Include a structure immediately upstream of all WQ or OSM facilities with a turned down elbow to prevent floatables from entering the facility.
10. Include a method to take the facility offline for servicing.
11. All facilities that include an underdrain shall be designed to minimize stagnant water in the underdrain system. This may require sloping of the bottom or adding weep-holes to drain this water off.
12. Splash Pads/Blocks must be designed to prevent erosion and scouring of the soil surfaces.

13. All facilities relying on soil percolation shall have a route of failure evaluated to protect surrounding areas and impacts on pedestrians.
14. Each facility shall be designed so "short circuiting" of the system is avoided.
15. If a liner system is proposed, care needs to be taken to detail liner penetrations and method off attachment to the facility wall. Engineering Services approval is needed for these details.
16. Any weirs or other devices designed to spread or disperse flow shall be designed with the ability to field adjust over the lifetime of the facility to account for settling and construction imperfections.
17. Where feasible, combine WQ and OSM into one facility.

J. Sanitary Sewer

This section relates to the design and construction of Sanitary Sewer systems.

1. The University sanitary sewers drain to King County Metro Truck sewers located on Montlake Boulevard, Pacific Street, and Pacific Place. Refer to University drawing 805RU-1 for a map detailing the campus sanitary sewer distribution system.
2. Coordinate with Engineering Services all new connection points to the University system.
3. The areas east of Montlake Blvd. and south of NE Pacific Street are mostly served by Sewer lift stations. See 805RU-01 for the locations of all lift stations.
4. Refer to University drawings 875RU-A through 875RU-E for all existing utilities. The above drawings are updated regularly but are schematic and may not be accurate or complete for some areas of campus.
5. Avoid the use of back water valves on side sewers. The Civil designer is to coordinate with the Mechanical designer early in the design process for situations requiring a back-water valve. A cost/benefit analysis must be done to compare the feasibility of such devices.
6. For side sewers, provide a cleanout approximately five feet from buildings. Minimum side sewer slope is 2.00%.
7. Refer to Utility Corridor Arrangement drawing (see Roadways section) for preferred piping placement under roadways.
8. Avoid the use of lift stations. Where lift stations are necessary discuss with Engineering Services. Provide remote high-level alarms, self-priming pumps, and auxiliary power with an automatic transfer switch.
9. Connect laboratory acid resistant waste lines and sanitary sewer pipe outside the building in an acid waste resistant / sanitary waste manhole as shown in detail SD-C-34.
10. Provide manhole numbers on the plans.
11. Pipe sizes, slopes, lengths, points of connection, trench and bedding details, connection and joint details, manhole sizes, , and clean-out details. Show horizontal separation between sewer and water. Show crossing utilities on profile.
12. Plan(s) showing all existing underground tunnels and utilities (power, communications, gas, water, storm drain, sanitary sewer, and street lighting.) A survey drawing may be adequate for this purpose, providing it has been reviewed to ensure that all utilities are included and that each utility is clearly distinguishable from other drawing information.
13. All products, materials, and equipment shall conform to WSDOT/APWA Standards.
14. Piping: SDR 35 PVC pipe per ASTM D3034 for sizes 12 inches in diameter and below, and reinforced concrete pipe per ASTM 67 for sizes above 12 inches in diameter. Exception: Use

ductile iron pipe or a ductile iron sleeve where high surface loads exist, under roadways, and where minimum cover cannot be achieved.

15. The Construction Coordinator shall make test arrangements with the Contractor and shall notify University Engineering Staff as to the date and time of testing. University staff must witness and approve all testing before the sewer may be placed in service.
16. Refer to the following City of Seattle (COS) Standard Plans:
    a. Manhole (COS 201b)
    b. Drop Connection (COS 233a)
    c. 8" Clean-out (COS 280)
    d. Typical Trench Section (COS 284)
    e. Pipe Bedding (COS 285)

K. Water

This section applies to the design and installation of water distribution systems.

1. Refer to drawing 804-RU-02 for the layout of the water distribution system.
2. Refer to University drawings 875RU-A through 875RU-E for all utilities. The above drawings are updated regularly, but are schematic and may not be totally accurate, complete, or up to date for all areas of the campus.
3. Design and install water distribution piping in accordance with American Water Works Association (AWWA) and the City of Seattle standards.
4. Design with bell and spigot and thrust blocks. On unstable ground (East Campus) consider using FM approved restrained mechanical joints. Discuss with Engineering Services.
5. Locate backflow preventers in basement mechanical rooms. Do not locate in vaults or pits without discussing with Engineering Services.
6. Coordinate with Engineering Services the need for water meters. Water meters are used as part of the campus energy system.
7. Provide separate fire and domestic services. Provide a post indicator valve on the fire service, preferably 40 feet away from the building, or on or near blank wall. Shared (water/fire) single services need to be approved by the UW Fire Protection Engineer.
8. Do not install water piping below slabs on grade.
9. Bury mains with 36 inches of cover from finish grade to top of pipe.
10. Coordinate Fire Hydrant locations with Engineering Services and UW EH &S.
11. Do not use restrained mechanical joints on existing mains without verifying existing pipe material.
12. The preferred location of vaults is away from areas of pedestrian traffic.
13. Provide building isolation valve.
14. Additional valves may be required by Engineering Services to minimize the disruption of water shutdowns during construction and for overall operations of the campus.
15. All products, materials, and equipment shall conform to AWWA and NFPA 24 standards.
16. Main pipe and fittings: Ductile iron with cement lining
17. Main line valves: Resilient seated gate valves per AWWA C509
18. Fire hydrants: (In order of preference) Waterous Pacer, Kennedy K81A or Mueller Super Centurion 250. Wet-taps: 300 series corrosion resistant steel sleeves, shells, lugs, bolts, washers, and nuts

19. Exterior below grade pipe penetrations: Link-Seals, or approved substitution
20. Environmental Health & Safety Design Guide – Sprinkler Protection and Standpipes
21. The following City of Seattle (COS) Standard Plans are approved for use where applicable:
    a. Connections to Existing Watermains (COS 300a)
    b. Connections to Existing Watermains (COS 300b)
    c. Hydrant Setting Detail (COS 310a). Exception: Paint with one coat of red oxide primer and one coat of University of Washington Green Sash Enamel.
    d. Cast Iron Valve Box & Operating Nut Extensions (COS 315a)
    e. Watermain Thrust Blocking Vertical Fittings (COS 330a)
    f. Watermain Thrust Blocking Vertical Fittings (COS 330b)
    g. Watermain Thrust Blocking Horizontal Fittings (COS 331a and 331b)
    h. Sewer and Water Spacing & Clearances (COS 286a and 286b)
    i. Typical Trench Section (COS 284)
    j. Pipe Bedding (COS 285)

L. Natural Gas

This section applies to the underground natural gas distribution system.

1. Puget Sound Energy (PSE) supplies high-pressure (above 60 PSI) natural gas to the main campus via a connection located at the south end of the power plant. The University owns all the natural gas piping supplied from that location on the main campus. University facilities at other locations, such as west campus, are served by PSE and are metered separately. See University drawing 806-RU-02 for more information.
2. The lower campus around the Medical Center / Hospital is served by a separate gas distribution system.
3. Refer to University drawings 875RU-A through 875RU-E for utilities. These drawings are updated regularly but are schematic and may not be completely accurate.
4. Design and install natural gas service and distribution piping in accordance with American Society of Mechanical Engineers Code for Gas Transmission and Distribution Piping Systems (ASME B31.8).
5. Bury piping with 36 inches of cover from finish grade to top of pipe. Use Seattle aggregate No. 9 for pipe bedding. Refer to the section on earthwork backfill requirements.
6. All products, materials, and equipment shall conform to ASME B31.8 “Gas Transmission & Distribution Piping Systems”.
7. Pipe and fittings: SDR 11 polyethylene with an accessible and properly grounded tracer wire. Use prefabricated fittings for transition from plastic to steel. Above-ground piping shall be steel. Use prefabricated fittings, designed to prevent stress from being transferred to the underground plastic pipe, when transitioning from underground polyethylene to above ground steel.
8. Valves: AGA or API listed polyethylene ball valve, with 2-inch square operator nut
9. Valve Boxes: Cast iron, two-section box. Include top section with cover and “GAS” lettering.
10. Exterior below grade pipe penetrations: Link-Seals, or approved substitution
11. Fabricate, install, and inspect all gas distribution and service piping in accordance with ASME B31.8. Include an air test at 90 PSI for 4 hours with no allowable pressure drop.
12. Installation shall be by PSE approved contractor.

13. Connect and activate new lines under the supervision of University staff.
14. University staff must inspect all gas piping installations before backfill.
15. Valves, piping, and fittings shall be heat fusion bonded polyethylene. Connections to steel piping shall be welded.
16. The University Construction Coordinator shall make test arrangements with the Contractor and shall notify University Engineering Services staff as to the date and time of testing. University staff shall witness testing before gas lines are placed in service.
17. Note all special requirements for separation and crossing the University Steam pipe.

M. Subsurface Structures

Tunnels

This section applies to reinforced concrete utility tunnels and trenches.

1. Refer to University drawings 875RU-A through 875RU-E for utilities not routed through campus utility tunnels. The above drawings are updated regularly but are schematic and may not be accurate or complete.
2. Do not install water, gas, sewer, or storm drain piping in utility tunnels or utility trenches.
3. Locate tunnels and manholes based on existing and planned facilities. New facilities shall be planned to avoid hindering egress out of tunnel system and to avoid affecting tunnel ventilation.
4. Avoid locating manholes in roadways. Do not locate manholes in walkways unless approved by Engineering Services. Tunnel manhole covers, if placed in paved areas, shall meet AASHTO H20 loading criteria and ADA requirements.
5. Slope floors towards the piping side of the tunnel to minimize water on walking surfaces.
6. Provide a tunnel drain as shown on tunnel and trench sections.
7. Provide for drainage of storm water entering the top manhole grating and offset the manhole opening to prevent rain water from entering the tunnel.
8. At top manhole grating at grade, provide steel grated ventilation openings with security locks bolted from below.
9. Provide connections for tunnel underdrains with cleanouts and maintenance structures.

Vaults

This section applies to the Civil Engineers component for new vaults and underground chambers.

Drains

1. Coordinate with other disciplines as to providing floor drains.
2. The University prefers gravity drains or gravel sump drains.

Lids / Grates

1. Coordinate with Structural as to final location, elevation, and load ratings for vault lids.
2. Coordinate location of openings to a spot outside any roads or walkways.
3. Assume H-20 rating.

Buildings

This section applies to the Civil Engineering component for the design of new underground buildings.

Top Surface

1. In general, guide the design development of underground buildings to avoid any low spots and the reliance on individual “roof” slab drains to convey excess storm or irrigation water off the top of an underground structure.
2. If a drain is unavoidable, in a low spot on the top of an underground structure, provide an inspection port directly over the drain structure to allow for monitoring and servicing of the drain.
3. Provide a perimeter drain along the outside edge of the structure to convey excess rain/irrigation water away from the structure. Provide cleanouts at 50-foot spacing minimum.

Perimeter Drain

1. Underground structures are to be assessed for how complete the water proofing needs to be. If the space below is to be occupied, provide redundant conveyances to assure no seepage in the event the water proofing fails. On garage structures this need may not be as great.

   Monitoring wells should be provided to assess how much water is present and provide a location to pumps out excess water

Storm System Design Criterion

1. The use of ANY round aggregate shall have pre-approval from Engineering Services. In general, its use should be avoided in any surface areas that can come in contact with mowers, trimmers or can be walked on.
2. Design and install storm sewers and appurtenances in accordance with WSDOT/APWA Standard Specifications and the City of Seattle Directors Rules.
3. Design storm drains to convey a 25 year, 24-hour storm event. Pipe can surcharge at this flow as long as 50-year storm event does not overtop rim elevation based on backwater calculations. Provide backwater calculations to Engineering Services.
4. Provide narrative describing impacts of 100-year storm event on downstream areas.
5. Where applicable provide knockout or stub out and cap pipe from structures for future connections.
6. For CB’s in curb line, next to sidewalk, stub out and cap a 6” pipe to the back of sidewalk.
7. Minimum pipe slope is 0.5%.
8. Minimum pipe size is 6”, generally.
9. Minimum pipe size is 8” in roadways.
10. 4” pipe may be used with consent from Engineering Services
11. Maximum Manhole spacing is 300 feet.
12. Maximum CB spacing in roadways shall be 150 feet.
13. Install redundant Storm Structures with thru curb inlets at all low spots in roads or ask for exception from Engineering Services.
14. Bury pipe with at least 24 inches of cover from finish grade to top of pipe.

15. Maintenance is of prime importance to the University. Locate all proposed structure so that they can easily be reached for servicing. Consider structures with no sump in locations where access is difficult directly near the structure. Minimize the use of structures that require maintenance.
16. Include clean outs in locations as outlined in the Uniform Plumbing Code. In general, at all locations where pipe changes direction and no more than 50 feet in pipe length.
17. Consider double cleanouts that allow pipe access in both directions, for pipe near or under hardscape and buildings.
18. Provide minimum 12" clear separation between all storm pipe and other utilities and ducts.

Sanitary Sewer Design Criterion

1. Design and install all sanitary sewer mains, side sewers (laterals), sewer lift stations, telemetering facilities, and sewer system appurtenances in accordance with WSDOT/APWA Standard Specifications and the Washington State Department of Ecology "Criteria for Sewage Works Design."
2. Bury mains with at least 36 inches of cover from finish grade to top of pipe. Use Seattle aggregate No. 9 for pipe bedding.
3. Shallow manholes (4-feet deep) are discouraged. If needed locate these manholes out of traffic areas and away from student gathering spots.
4. Generally, use pipe that is 6 inches or larger in diameter. Sewer pipe 4 inches in diameter may be specified if approved by Engineering Services.
5. For gravity sewers, provide a manhole every 300 feet or less, and at changes in pipe direction or diameter.
6. Cleanouts are to be installed at changes in pipe direction and at least every 100 feet of side sewer.
7. 8-inch side sewers generally require a manhole at connection points with the main. Coordinate this with Engineering Services.
8. Use 54-inch diameter manholes (minimum) unless approved by Engineering Services.
9. Rim elevations. For manholes on hillsides or landscape areas set rim elevations 6-inchs above the adjacent uphill elevation. Avoid setting manholes in grass areas. If unavoidable set rims low to avoid lawn mower damage.
10. 18-inches is the maximum step down in manhole inverts without a drop. When drops are needed the University prefers inside drop connections per City of Seattle detail.
11. Pipe connections: Use fittings made of the same material as the connecting pipe. Use an appropriate adapter when changing materials (e.g. when penetrating a concrete manhole with a PVC pipe.)
12. Exterior below grade pipe penetrations: Link-Seals, or approved substitution
13. Manhole lids: Locking, Ductile iron, permanently marked "SEWER".
14. If practical, do not locate manholes and cleanout structures under parking stalls, high traffic areas, or locations not easily accessible by vactor trucks.
15. All sewer pipe with a depth of 18 feet or more must be ductile iron.
16. If a building is proposing a separate acid resistant waste (ARW) line then provide a manhole near the building that combines the waste and ARW lines.
17. All sewer pipe shall be identified by installation of a 16-gauge solid tracer wire attached to the top of the pipe and by "sewer" warning tape installed 18-inches above the pipe.
18. Maximum 6-inch side sewer length shall be 200 feet with a cleanout at 100 foot intervals and at the end.

Architectural

A. Substructure

1. Foundation

STANDARD FOUNDATION SUPPLEMETARY COMPONENTS (A1010.90)

a. All cold joints in concrete foundations shall have water stops.
b. When geotechnical reports indicate that a subgrade perimeter (footing) drainage system is required, the acceptable drainage course used is a three dimensional, crush-proof drainage coarse with a non-woven needle punched filter fabric system.

2. Subgrade Enclosures (A20)

WALLS FOR SUB-GRADE ENCLOSURES (A2010)

SUBGRADE ENCLOSURE WALL SUPPLEMETARY COMPONENTS (A2010.90)

Commissioning

This section requires commissioning as outlined in (BECx).

Waterproofing (07 10 00)

a. Vertical surfaces below grade adjacent to occupied or service spaces shall be treated with a fully adhered membrane waterproofing system. The acceptable waterproofing membrane used on campus buildings is hot fluid-applied rubberized asphalt (cold fluid applied applications in limited conditions with Facilities Architect approval). Damp-proofing may be used at utility rooms in parking garages when soil exploration determines no ground water is present.
b. Protection board for applied membrane is required to prevent damage from backfill or other construction activities. Protection board used is extruded polystyrene that complies with ASTM C 578, Type IV, with compressive strength of 25 psi and R-value of 10. Other systems are acceptable if they meet or exceed the technical performance criteria of the above system.
c. Extend the waterproof membrane up walls and curbs adjacent to a roof or horizontal surface a minimum of 1 foot, and a minimum of 4 inches above pavers, sidewalks or planting soils, whichever is greater. Terminate the membrane with continuously sealed joint and protect with metal counter-flashing set in a reglet or other reveal. Tie the waterproofing to the building enclosure weather air barrier.
d. The acceptable flexible flashing compatible with the waterproof membrane system used is uncured neoprene sheet.
e. New waterproofing products and/or systems must be submitted to FA for consideration in any new construction.
f. Where a hot fluid-applied rubberized membrane is technically infeasible (e.g. over-excavation not possible) on below-grade walls and around utility tunnel construction, a

sheet waterproofing system may be approved by FA. Basis of Design is an expandable, self-sealing bentonite geotextile composite sheet system.

g. Where sheet water-proofing is approved, vertical laps are preferred. Make water tight per manufacturer's standard recommendations.
h. At penetrations make water tight. Follow manufacturer's standard recommendations.
i. 2-year minimum installation warranty required for ALL waterproofing systems; from date of Substantial Completion. The installed waterproofing system shall have a no dollar limit life time warranty.
j. Protect all edges, termination etc. from foreign objects during construction.
k. Products damaged during construction shall be replaced.

Insulation (07 20 00)

Install all rigid insulation with tight joints (no gaps).

3. Slabs On Grade (A40)

SLAB-ON-GRADE SUPPLEMENTARY COMPONENTS (A4090)

A4090.20 Vapor Retarder (07 26 00)

a. Maintain permeance of less than 0.01 Perms. (Coordinate with requirements of floor finish materials).
b. Strength: ASTM E1745 Class A.
c. Thickness: 20 mils minimum
d. Laps and penetration shall be sealed water tight.
e. Products damaged during construction shall be replaced.

A4090.30 Waterproofing (07 10 00)

a. If the soil report indicates any ground water above the lowest slab level or is recommended by soils investigation, an under-slab waterproof barrier and drainage system is required. Basis of Design is an expandable, self-sealing bentonite geotextile composite sheet system.
b. All elevator pits shall have an under-slab waterproof barrier.
c. Products damaged during construction shall be replaced.
d. Water stops shall be installed in all cold joints.
e. Laps and penetrations shall be made water tight.

B. Shell

SUPERSTRUCTURE (B10)

1. Stairs (B1080)

STAIR CONSTRUCTION (B1080.10)

Precast Concrete Stairs (03 41 23)

a. Fabricator Qualifications: Plant must be certified by the Precast/Prestressed Concrete Institute (PCI) Plant Certification Program and shall be certified in category C4.
b. Quality Control: PCI MNL 116, Manual for Quality Control for Plants and Production of Precast Concrete Products" and the PCI MNL 135, "Tolerance Manual for Precast and Pre-stressed Concrete Construction".

Treads, Nosings and Landings (05 55 00)

a. No extruded aluminum nosings at exterior applications.

METAL WALKWAYS (B1080.70)

Metal Catwalks (05 51 36.13)

a. Aluminum is not allowed
b. Walking surfaces shall be non-slip or abrasive.
c. Minimum finish is to be galvanized (G90).

LADDERS (B1080.80)

Roof Ladders

a. Ladders are required at roof hatches and exterior access to different roof elevations that are not provided with separate roof hatches.
b. No offset stepladders.
c. Vertical members to be 1-1/2" standard pipe. Rungs to be ¾" round minimum with non-slip surfaces.

2. Exterior Vertical Enclosure (B20)

EXTERIOR WALLS (B2010)

EXTERIOR WALL VENEER (B2010.10)

Commissioning

a. Include all work under this section in Building Enclosure Commissioning (BECx).

Precast Concrete (03 40 00)

a. Stainless steel anchors and picks shall be used on exterior precast concrete.
b. All exterior application of concrete cladding shall be a ventilated rain screen system.

Unit Masonry (04 20 00)

a. Masonry or brick veneer shall not be used below grade.
b. Steel reinforcing in cast stone that is less than a ¼" thick or has less than a 1.5" cover shall be non- corrosive.
c. Use stainless steel anchors and picks.
d. Use materials that inhibit efflorescence.
e. Joints between dissimilar materials to accommodate thermal movement in horizontal and vertical direction.
f. During installation of masonry systems, the open top of the cavity must be covered with a canopy at the conclusion of the work day to prevent water intrusion and future efflorescence.
g. Material overstock is required when specialty masonry is used; quantities TBD.
h. Type-N mortar is preferred, tooled concave joint face.
i. Use only fresh mortar, no re-tempering, remove fins and droppings from cavities.
j. Set in full mortar beds; do not move once initial set has taken hold.
k. Place in lifts no greater than 4 feet: hold down from tops of wall 1 inch minimum.
l. Masonry Ledger Supports
    i. Galvanized (G-90) steel angles and bent plates, ¼-inch thickness or greater. Shop fabricate and galvanize (G-90); make no field cuts; set level, allow ¼ inch between pieces for movement.
    ii. Insert wedge anchors, Galvanized (G90).
    iii. Stainless steel expansion anchors may be used when cast-in-place anchors miss their mark.
    iv. Epoxy anchors are not acceptable to support ledger angles and in grouted CMU construction.
m. Wall Ties
    i. 12 gauge stainless steel plate and 11 gauge stainless steel pintle accepting 9 gauge stainless steel wire. Install ties with 2 anchors each (minimum).
    ii. Dovetail type anchors are not acceptable.
n. Masonry Embedded Flashing
    i. Stainless steel (26 ga when concealed, 24 ga when exposed) or copper (24 oz.) under masonry. Both with hemmed drip
    ii. Counter flashing to back-up wall may be metal or flexible membrane.
    iii. Horizontal surfaces must slope to exterior.
    iv. Terminate flexible flashing with metal bar; anchor to wall at 12 inches on center; seal top edge, form corners and ends carefully to promote drainage.
    v. Shop fabricate corners and ends, weld or solder seams; laps to be 4 inches minimum; set laps in sealant.
o. Masonry Cavity Drainage, Weep holes, and Vents

i. Open head joints at 24-inches on center.
ii. Bottom and top of walls.
iii. Keep clear of mortar; use open head joints.
iv. Slotted weep holes only. No round weeps. No rope weeps.
v. Air Space (at Drainage Wall)
   (a) 2-inch minimum clear
   (b) Keep clear of all materials
   (c) Consider using pvc mesh

p. Shims for Setting Masonry
   i. Use Non-corrosive or non-metallic shims only.
   ii. Use Galvanized (G90) steel shims to be used for brick.
   iii. Shims in setting beds shall not be exposed.

q. Seismic Stabilization of Existing Masonry Veneer
   i. When masonry repairs or restoration occurs, the existing masonry veneer around entrances shall be anchored to structural frame:
      (a) A distance of 20’ from edge of door from grade to top of parapet.
      (b) From top of door to parapet.
      (c) From grade to top of parapet when exit path is adjacent to exterior wall.

Exterior Insulation and Finish Systems (07 24 00)

a. No EIFS systems shall be used.

Wall Panels (07 42 00)

a. Wall panels shall be open joint rain screen system.
b. System shall be thoroughly designed, tested and detailed by the systems supplier prior to the start of work.
c. All fasteners shall be concealed.
d. Barrier wall systems prohibited.
e. Metal panels shall have no noticeable oil canning.
f. Rain screen manufacturer shall provide on-site inspection and 25 year warranty of product.
g. Panel Support Systems must perform as designed for the lifetime of the panel material.

Faced Panels (07 44 00)

a. Panel Support Systems must perform as designed for the lifetime of the panel material.

Siding (07 46 00)

a. Vinyl siding prohibited.
b. Wood may be used in appropriate applications with prior approval from FA. Teak / Pressure treated Pine and hardwoods are preferred for longer life. Wood that requires resealing every few years should be avoided for exterior applications.
c. Manufacturer recommended and approved fasteners must be used in all pressure-treated wood applications.

d. Treat all exposed edges.
e. Field modified cladding edges need to be retreated with protective coating.

Water Repellents (07 19 00)

a. All porous masonry materials shall be treated with a solvent based water repellant sealer system.
b. Penetrating type graffiti sealing is required on all non-historic building envelopes to top of the second-level at a minimum. Application method of sealant must not come into contact with the ground or waste water systems.

EXTERIOR WALL CONSTRUCTION (B2010.20)

Unit Masonry (04 20 00)

a. Unit masonry shall have fully grouted cells

Metal stud framing (05 41 00)

a. Metal stud framing at masonry veneer walls - entire wall system shall be designed to meet BIA Tech Notes on Brick Construction 28B (e.g. Restrict allowable out-of-plane deflection of steel studs to L/600 using service level load).
b. Minimum 18 gauge galvanized G60 metal stud @ 16” O.C.
c. Exterior metal framing to be designed to carry all applicable loads e.g. cladding, windows etc.
d. If cold formed metal framing is incapable of sufficiently carrying applied loads, additional structural framing shall be provided.
e. Only screwed or welded connections shall be used in exterior framing. Crimped connections prohibited.
f. Provide detailed shop drawing elevations showing framing, openings, dimensions of rough openings, connection points for all elements supported by framing.

Wood framing

a. All exterior wood framing outside the weather barrier to be preservative treated.

FABRICATED EXTERIOR WALL ASSEMBLIES (B2010.40)

Commissioning

a. Include all work under this section in Building Enclosure Commissioning (BECx).

Curtain Wall Assemblies (08 44 00)

a. No reflective glazing or reflective window film shall be used.
b. Interior Wet/Dry Method (Tape and Sealant) or Interior Dry Method (Tape and Tape) are permitted.
c. Provide minimum manufacturer’s warranty period of ten (l0) years from the date of

manufacture for dual seal units vertically glazed. Insulating units in sloped glazing applications shall be warranted for a period of five (5) years from date of manufacture. Warranty to include all costs associated with unit replacement.

d. On-site representation from manufacturer during construction
    i. To assist with unforeseen conditions
    ii. To assist in quality assurance
    iii. To assist with intersections with other systems, i.e., metal wall systems
e. Curtain wall and window performance criteria: All systems shall meet the following minimum criteria in addition to industry standard practice.
    i. Air infiltration: As required by the Seattle Energy Code or International Energy Conservation Code (the most strict shall take precedence). Test in accordance with ASTM E283
    ii. Water penetration: Test in accordance with ASTM E331. At a pressure of 8psf, no water shall penetrate to any inside surface.
    iii. Coordinate with requirements for "Safe Access and Fall Protection”.
f. Curtain wall designs that utilize custom extrusions are highly discouraged. If custom extrusions are proposed, the following steps shall be taken:
    i. Design, manufacture and test a performance mock-up of the proposed system in accordance with project design and performance criteria.
    ii. Test finished system in place. Test shall be performed in accordance with the Curtain wall Performance Criteria above. Hybrid systems of curtain wall which include other elements such as entry doors, metal panels and operating sash shall be tested as part of the curtain wall.
    iii. Requirements for a mock-up of custom designs may be waived if sufficient documentation can be produced to prove the performance of the custom design.
    iv. Testing procedures shall be approved by FA.

PARAPETS (B2010.50)

a. Parapets shall have permanent waterproof coping, flashing or capstones.
b. Parapets with capstones or masonry shall have through wall flashing over the moisture protection membrane.
c. Secure capstones to the parapet with stainless steel dowels. Seal dowels at through wall flashing with flexible flashing and sealant.

EXTERIOR WALL SUPPLEMENTARY COMPONENTS (B2010.80)

Weather Air Barriers (WAB) (07 25 00)

a. Must be continuous around the entire building enclosure.
b. Sealants shall never be used for the primary weather barrier.
c. Materials specified in exterior wall, shall have manufacturer’s statement of compatibility with adjacent materials and finishes.
d. Weather barrier manufacturer shall provide on-site inspection and product warranty of

25 years. Warranty to include replacement of weather barrier system along with all other associated components/damage at no cost to UW.

e. Weather barrier to have and installation warranty of 10 years. Warranty to include repair of weather barrier system along with all other associated components/damage at no cost to UW.
f. Damp proofing shall not be used as a weather barrier
g. Loose applied sheet products shall not be used as a weather barrier.
h. Fluid applied weather barrier shall be used.
i. Weather barrier shall be continuous thru joints without depending on sealant or tape for performance.
j. Protect exposed weather barrier systems as recommended by manufacturer against degradation by UV, moisture etc.
k. Protect building enclosure at each phase of installation from weather damage & exposure. Check daily for damage in previously installed work prior to continuing installation of new building enclosure materials. Damaged materials must be removed and replaced.
l. Personnel installing the products shall provide evidence of factory training and certification. Certification of individuals is required, not just certification of installing contactor.
m. During warranty periods, water damage to any other building component and/or building contents due to product defect and/or incorrect installation requires correction at no cost and no dollar limit to the UW.

Fasteners (05 05 23)

a. All exterior fasteners in the drainage plan or a ¼" diameter or smaller are to be stainless steel.

Expansion Joints (07 95 00)

a. Sealants at dissimilar cladding materials to accommodate thermal movement in horizontal and vertical directions without failure.
b. Sealants at exterior systems to have 50% elasticity elongation
c. Sealants at exterior systems shall have minimum of 15 year warranted life.
d. Sealants shall be UV stable
e. Closed cell backer rods are preferred in exterior joints
f. Provide for adhesion tests for all materials and sealants.
g. Prime joints where required for adhesion.
h. Consider sand textured finish on masonry sealant joints.

EXTERIOR WALL OPENING SUPPLEMENTARY COMPONENTS (B2010.90)

Flashing (07 60 00)

a. All flashing shall be designed to accommodate expansion without buckling, "oil canning", or warping.
b. All corners and horizontal to vertical transitions shall be shop fabricated and made water tight.

c. Provide for thermal movements from the maximum change in ambient and surface temperatures as specified by manufacturers.
d. Provide clips that resist rotation and avoid shear stress as a result of thermal movement.
e. To accommodate horizontal and vertical construction tolerances, consider using 2-piece flashing systems. Counter flashing may be a material other than metal.
f. All penetrations, openings, etc. through the exterior skin of the building must be protected by head and sill (w/ back pan design) flashing.
g. All exposed and through wall flashing shall be metal.
h. Metal flashing shall be minimum thickness as follows:
    i. Stainless steel, 24Ga. (.018 inch);
    ii. Copper, 16oz. per square foot
    iii. Coated galvanized steel, 24Ga (before coating and galvanizing);
    iv. Aluminum, .032 inch.
i. Coatings for flashing shall be high-performance coatings, e.g. epoxy, polyurethane and fluoropolymer.
j. 5-year installation warranty required for all flashing; from date of Substantial Completion. Warranty includes installation, leaks, displacement, failed joints, and damages to other building components impacted by failure.

EXTERIOR WINDOWS (B2020)

EXTERIOR OPERATING AND FIXED WINDOWS (B2020.20)

Windows (08 50 00)

a. Materials:
    i. Frame: Extruded aluminum. Other materials used for historic restoration may be considered with approval from the FA.
    ii. Anchoring elements: Stainless steel or aluminum or approved by FA.
    iii. Shims: No-corrosive metal or high density plastic
    iv. Hollow metal is not acceptable.
    v. Operable ground level windows opening out, are to have 6-inch limiters to avoid entry or injury from the exterior.
    vi. Finishes:
        (a) High performance fluoropolymer coating: Comply with AAMA 2605-98
        (b) Anodized aluminum: Comply with Class I anodizing conforming to AAMA 611-98
        (c) Powder coating: Comply with AAMA 605.2-90
        (d) Other high-performance coatings as approved for interior surfaces.

EXTERIOR WINDOW WALL (B2020.30)

Storefronts (08 43 00)

a. Entrances and Storefronts shall have an (AAMA, 2017) Certification Label and comply with applicable provisions of (ANSI, 2017) (AWS, 2017), (OSHA, 2017) (AA, 2017) and (WISHA, 2017).

b. Coordinate storefronts and windows with adjacent cladding systems and support framing.
c. Storefronts and similar systems shall not be used when exposed to weather.
d. On-site representation by the manufacturer is required to advise on coordination with unforeseen conditions, for quality assurance and to assist with intersections at other building systems.

3. Exterior Horizontal Enclosure (B30)

ROOFING (B3010)

LOW-SLOPE ROOFING (B3010.50)

Low-Slope roofing Membrane (07 50 00)

a. 30-year manufacturer warranty required for all roofing systems from date of Substantial Completion unless stated otherwise.
b. The preferred membrane roofing system is a Torch-Applied SBS (Styrene-Butedien-Syrene) Modified Bituminous Membrane. See Preferred Vendors document for accepted products.
c. Single ply and ballasted roofing systems are prohibited.
d. Adhere to the standards and details of the latest editions of the NRCA Roofing Manual and manufacturer's product data.
e. Hot rubberized asphalt waterproofing shall be used on horizontal surfaces over occupied spaces (e.g. plaza decks). Any drains installed at fixed pavers shall have two level inlets, at the finish surface and at the membrane level.
f. All roofing work to be done by a qualified roofer certified by product manufacturer to do the work.
g. Any alterations to the existing building enclosure[1] must be coordinated with FA prior to setting scope & budget.
h. For existing building repairs, selected roofing materials must be compatible with existing roofing materials to maintain original warranties.
i. When modifying existing roofing, protect the building from water infiltration.
j. All penetrations of the building enclosure must be air and watertight.
k. Slope the structural framing under plazas, decks, roofs and any below-grade space ¼"/ft. minimum towards drains or over the edge of foundation walls to accommodate drainage. Avoid using insulation to achieve roof drainage except at crickets and saddles.
l. In new construction vapor barrier may be used as a temporary roof during construction. Protect vapor barrier while performing other construction on the roof. Apply a new layer of vapor barrier prior to completion of roof installation.
m. Vapor barrier must extend vertically at all curbs, parapets and other penetrations

[1] Building enclosure – includes roofs, exterior walls, exterior windows & curtain walls, exterior doors, below grade construction, balconies, canopies, decks, patios, utilities and other elements attached to the exterior of a building.

minimum 6” higher than adjacent finished roof or overburden.

n. At all horizontal enclosures over occupied spaces (e.g. plaza decks, roofs, etc.), provide for leak detection testing for the primary water proofing barrier (electronic leak detection or flood testing).

ROOFING SUPPLEMENTARY COMPONENTS (B3010.90)

Substrate Board (09 28 00)

a. Substrate boards over steel decking and over insulation shall be cement board.

Deck Insulation (07 22 00)

a. When insulation is applied to underside of roof deck, that insulation must be compatible with roof deck and vapor barrier must be continuous and completely sealed at perimeters.

Vapor Retarder (07 26 00)

a. Vapor retarders must be continuous and fully sealed.

Air Weather Barrier (07 27 00)

a. Air Weather Barriers must be continuous and fully sealed.

Sheet Metal Counter Flashing and Trim (includes seismic joint covers) (07 62 00)

a. All roof flashing must be metal.
b. Pre-manufactured seismic joint covers are prohibited.
c. Follow SMACMA manual for suggested details.

Roofing Flashing (07 65 00)

a. Must be compatible with roofing material.
b. Fluid applied flashing must be installed under strict conditions acceptable to the product manufacturer.

Copings (07 71 13)

a. At metal copings provide standing seam joints in copings unless material thickness prevents the forming of a watertight coping joint. The standing seam shall be sealed internally with Butyl Sealant.

ROOF APPURTENANCE (B3020)

ROOF ACCESORIES (B3020.10)

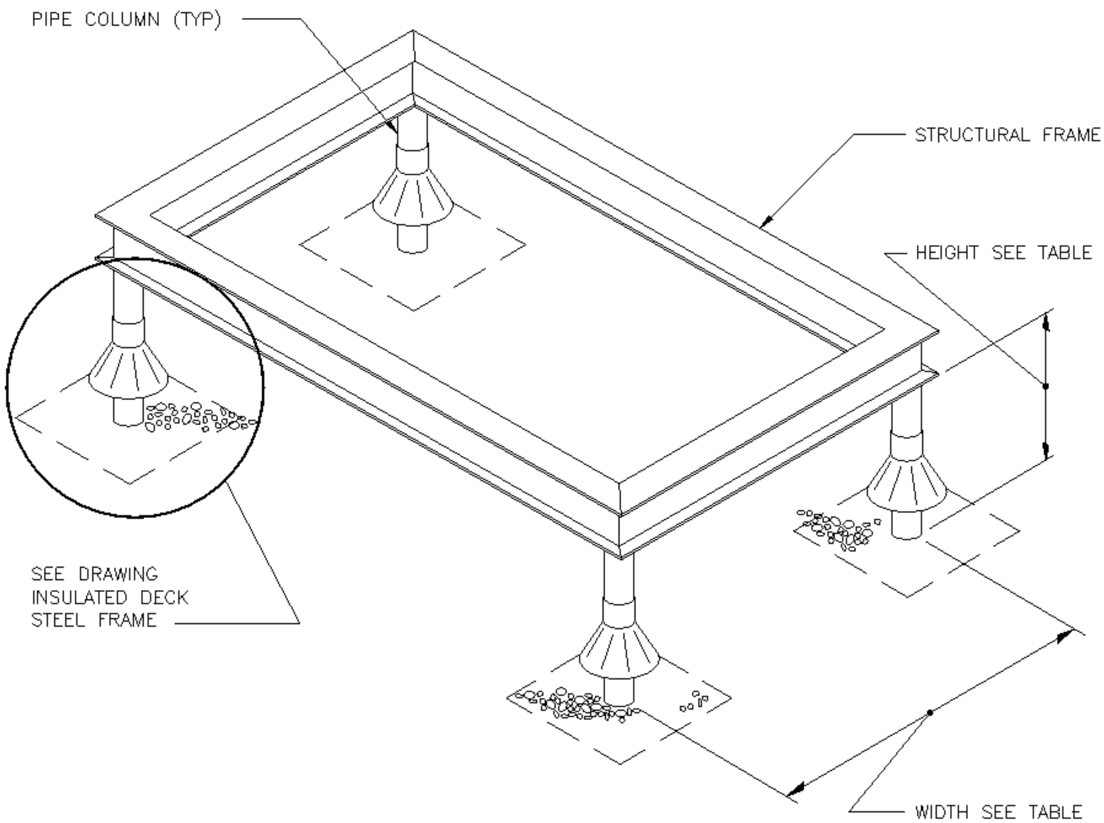
Roof Ladders (05 51 33)

See also:

Ladders: B1080.80

Roof Curbs (07 72 13)

a. Roof mounted equipment is not desired. Place all equipment within a penthouse to reduce foot traffic and therefore reduce leaks.
b. If roof mounted equipment is unavoidable, the support base shall be either a concrete slab designed for the specific equipment and tied into the structural deck or a stand according to attached drawings “Mechanical Equipment Stand and Insulated Deck Steel Frame” or a curb 1’-0” above finished roof surface, minimum.
c. Any equipment sitting on top of a curb shall be attached to the sides of the curb. Penetrations to the top of the curbs are prohibited.



WIDTH OF EQUIPMENT	HEIGHT OF LEGS
UP TO 24"	14"
25" TO 36"	18"
37" TO 48"	24"
49" TO 60"	30"
61" AND WIDER	48"

NOTE :

THIS DETAIL IS PREFERABLE WHEN THE CONCENTRATED LOAD CAN BE LOCATED DIRECTLY OVER COLUMNS OR HEAVY GIRDERS IN THE STRUCTURE OF THE BUILDING. THIS DETAIL CAN BE ADAPTED FOR OTHER USES, SUCH AS SIGN SUPPORTS.

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MECHANICAL EQUIPMENT STAND DETAIL

RAINWATER (B3020.70)

a. Perimeter drainage of roofing with scupper overflow is preferred over interior drains.
b. Where drains are not located at the exterior wall, they shall be at points of maximum deflection of the structural roof deck. Drains shall be located off of centerline to minimize interference with columns, beams and bearing walls.
c. All drains and overflow drains shall be located in a sump.
d. Flash all drains with 4 lb. per square foot sheet lead in addition to the membrane flashing.

HORIZONTAL (GLAZED) OPENINGS AND GLAZED ROOFS (B3060)

B3060.10 - Roof Windows and Skylights (08 60 00)

a. Roof penetrations must be a part of and integrate with the building Weather Air Barrier (WAB).
b. All roof opening shall sit on either a roof curb or stem wall. Curbs shall extend a minimum 1'- 0" above the roof surface.
c. Water penetration: Test in accordance with ASTM E331; at a pressure of 8psf, no water shall penetrate to any inside surface.
d. On-site representation from manufacturer during construction
    i. To assist with unforeseen conditions
    ii. To assist in quality assurance
    iii. To assist with intersections with other systems, i.e., metal wall systems
        (a) All skylight assemblies shall be a thermally broken system.
        (b) All exterior fasteners in the drainage plan or a ¼" diameter or smaller are to be stainless steel.
        (c) Horizontal glazing shall be designed for 25 lbs. live load.
        (d) Finishes:
            (1) High performance fluoropolymer coating: Comply with AAMA 2605-98
            (2) Anodized aluminum: Comply with Class I anodizing conforming to AAMA 611-98
            (3) Powder coating: Comply with AAMA 605.2-90
            (4) Other high-performance coatings as approved for interior surfaces.

C. Interiors

1. Construction (C10)

INTERIOR DOORS (C1030)

INTERIOR SWINGING DOORS (Body C1030.10)

a. Interior metal doors – 18ga. cold rolled steel. Seamless – tack weld, grind smooth, fill and touch-up paint.

b. Exterior metal doors – 18ga. A60 galvanized. Seamless – tack weld, grind smooth, fill and touch-up paint.
c. Metal doors shall be internally reinforced for surface mounted hardware and cut-out, drilled and tapped to receive mortised hardware.
d. Wood doors shall be 5-ply with engineered core at non-rated and 20 min. openings and Mineral core at 45, 60 and 90 min. rated openings.
e. Wood doors shall be internally reinforced for attachment of hardware.
f. Glass doors must be able to receive an automatic door opener.

INTERIOR ACCESS DOORS AND PANELS (C1030.80)

a. No plastic access doors and/or panels.
b. No key access. Access must be possible by hand-actuated quarter turn hardware; removal of multiple screw is also not acceptable.

INTERIOR DOOR SUPPLEMENTARY COMPONENTS (C1030.90)

Frames (08 10 00)

a. Interior hollow metal - 16ga. cold-rolled steel. Continuous face welded, dressed and ground smooth.
b. Exterior hollow metal – 16ga. A60 galvanized. Continuous face welded, dressed and ground smooth.
c. No knock down aluminum door frames.
d. All internal supports for hardware block-outs shall be adequate to support the door.

Glazing (08 80 00)

a. Vision panels shall be installed in doors intended for frequent use that swing into circulation. They shall be installed at max. 43” AFF.

Hardware (08 71 00)

a. Construction keying and final keying is by Facility Services.
b. NO narrow style hardware is allowed; medium or wide styles only.
c. Oversized doors are to use wide-style hardware only.
d. NO floor closers and floor hinges at exterior doors.
e. Continuous hinges are to be used at exterior, oversized and heavily used doors.
f. Out swinging lockable doors shall have NRP hinges.
g. Provide (1) intermediate pivot for every additional 30” of door height over 60”.
h. Doors in building separation walls and horizontal exits shall be proprietary. See Preferred Vendors document.
i. See **Preferred Vendors document** for allowed door hardware

SUSPENDED CEILING CONSTRUCTION DOORS (C1070)

C1070.10 - Acoustical suspended Ceilings (09 51 00)

a. NO spline ceilings.
b. T-bar grid to be a standard 1" in width.
c. No fiberglass batt insulation at removable ceilings.
d. Porous ceilings (tiles and/or systems) are not to be used in 'wet', clean, or sterile applications.

2. Finishes (C20)

WALL FINISHES (C2010)

Painting and Coating (C2010.70)

a. All interior finishes shall be low VOC.
b. Clean pipe, conduit, and similar features before applying paint or other finishing materials.
c. NO painted galvanized.
d. NO 'cold' or spray-on galvanizing.
e. Do not cover or paint any signs, labels, identification, etc. If covered or painted, the contractor is required to replace items.
f. Finishing of exposed Mechanical and Electrical Equipment:
    i. Prime and paint exposed pipes, conduit, boxes, ducts, hangers, brackets, collars and supports, except where items are shop finished or insulated.
    ii. Paint interior exposed conduit and electrical equipment except in mechanical rooms. Galvanized conduit must be pickled, primed, and receive 2 finish coats.
    iii. When painting ventilation grills, access panels, etc. remove item(s) and paint separately.
g. Exterior metal accessories:
    i. Galvanized when accessories are poured in place and/or not removable for refinishing.

Wall Finish Supplementary Components (C2010.90)

a. Wall (e.g. wall guards, chair rails, etc.) and corner protection must be installed in all public areas.

FLOORING (C2030)

Flooring Treatment (C2030.10)

a. All floor finishes shall have a dry static Coefficient of Friction (COF) of 0.6 on any flat or horizontal surfaces both wet and dry. All inclined or ramp areas shall have a COF of 0.8, as tested using the ASTM C1028.
b. Polished concrete in public areas is preferred.

c. The number of transitions from hard to soft flooring is to be minimized.
d. All concrete slabs are to be sealed unless concrete is polished or receives additional floor coverings.

D. Site Work

SITE IMPROVEMENTS (G20)

PEDESTRIAN PLAZAS AND WALKWAYS (G2030)

G2030.10 - Pedestrian Pavement

a. Acid-etched and/or sandblasted finishes are not allowed on walking surfaces.
b. No sealant between concrete sections in site paving. Use 3/8" asphalt impregnated fiber expansion joint filler.

G2030.40 - Tactile Warning Surface (32 17 26)

Tactile warning surfaces for sidewalks leading up to a vehicular roadway or route shall be "white".

Structural

A. General Requirements

1. **Design Live Load.** Provide key plans of each building level that clearly indicates the design live load used for each different area including the roof. Indicate if live load reduction is utilized in the design. This information will assist the University during future tenant improvements etc.
2. **Structural Details.** The structural engineer is required to design all the structural details for the building. Fabricator/contractor designed details are not allowed. The use of "Similar" details is discouraged. If "Similar" details are used where appropriate, then specifically indicate on the detail just what is "similar" about it.
3. **Congested Spaces.** Provide "study" type building sections to illustrate how the installed work of all the disciplines fits into congested spaces. An example would be to show how the structure, fireproofing, ceiling, ductwork, cable trays, sprinkler piping etc. fits into a lab corridor space using the available floor-to-floor height. Show how the layering of the mechanical and electrical system are accessible for maintenance and repair etc.
4. **Penetrations.** Coordinate penetrations through structural members due to other trades.
5. **Building Envelope Maintenance Equipment.** Coordinate building envelope maintenance equipment: including swing stage anchors/loads and fall arrest anchors etc.
6. **Vibration and Acoustics.** Coordinate vibration and acoustic requirements due to mechanical or other equipment.
7. **Site Vault Lids.** Site vault lids shall be designed to support HS 20 wheel loads.

B. Seismic Improvements and Building Modifications

1. Seismic Studies

a. **Study Components.** Seismic study shall include copy of evaluation checklists, structural calculations, and prioritized list of deficiencies to be corrected.
b. **Submittal Timing.** Seismic studies shall be submitted to Engineering Services for review and discussion at a design team meeting prior to issuing final report.

2. Seismic Upgrades

a. **URM Buildings.** In Unreinforced Masonry (URM) Buildings, where the roof and floor structure is supported by a URM wall, provide secondary structure to support the vertical loads of the roof and floor members. This includes support of all the floor and roof structure including joists, beams, girders, rafters etc.
b. **Essential Facilities.** For hospital and other essential facilities utilize the following Enhanced Rehabilitation Objective: Immediate Occupancy Performance Level (1-B) at BSE-1 Earthquake Hazard Level, and Collapse Prevention Performance Level (5-E) at BSE-2 Earthquake Hazard Level.

c. **Existing Structural Defects.** All existing structural defects discovered during design, demolition, and construction shall be repaired. This includes patching of spalls at exposed rebar in slabs, beams, and columns.
d. **Campus Studies.** In addition to the drawings maintained in Campus Engineering Records, the University has completed structural analysis studies of some of the buildings on campus. Also, in October 1991, the Earthquake Readiness Advisory Committee (ERAC) at the University of Washington issued a report detailing its findings of its campus-wide seismic hazards survey. The purpose of the ERAC report was to establish a consistent set of rules to prioritize which existing buildings needed further seismic analysis. The ERAC report also prioritized existing buildings according to Damage Index numbers and Life Safety Index numbers and recommended a number of facilities that should have further detailed seismic analysis performed by a licensed structural engineer. A pdf copy of the ERAC report is available from Engineering Services.

3. Modifications to Existing Buildings

a. **Renovated Structures.** The resulting structure shall be at least as strong as or stronger than before the modifications. In no case shall the structure be weakened by the modifications. This applies to both gravity loads as well as lateral (seismic and wind) loads.
b. **Lateral Load Strength.** Re-establish lateral load strength of the building if wall penetrations are cut into shear walls.
c. **Diaphragm Effects.** Analyze lateral load diaphragm effects if floor or roof penetrations are significant.
d. **Existing Structural Defects.** All existing structural defects discovered during design, demolition, and construction shall be repaired. This includes patching of spalls at exposed rebar in slabs, beams, and columns.

C. Foundations, Shoring, Slab on Grade, Sub-Grade Walls, Tunnels

1. Foundations

a. **Montlake Landfill.** Structures located on the Montlake Landfill that are supported on piling need to have the piling extend down to the underlying firm clay layer in order to avoid additional loading on the refuse and peat.
b. **Drilled Piers.** Concrete placed into drilled piers shall be conveyed in a manner to prevent separation or loss of materials. In no case shall the concrete be allowed to freefall more than 5 feet. Tremie concrete where required.
c. **Temporary Foundations.** Temporary foundations, such as for tower cranes, that are outside the footprint of the building need to be removed.
d. **Utility Tunnels and Clearance.** Locate piling, drilled piers etc. no closer than 3 feet clear from the outside face of existing utility tunnels or vaults.

e. **Utility Tunnels and Loading.** New construction shall not impose any added load or surcharge to the existing utility tunnel or vault walls or lid/top.
f. **Water Table.** If the foundation extends below the water table, demonstrate how the design team will address the issues involved with designing and constructing a structure below the water table. This effort should include, but not be limited to the following:
   i. Temporary dewatering the site for construction.
   ii. Permanent sub-grade wall and/or under slab drainage systems if needed.
   iii. Penetrations through the waterproof membrane for utilities, drainage systems etc.
   iv. Excavation type, laid back or shored, shoring location relative to subgrade walls.
   v. Show how rebar and formwork etc. is to be supported without penetrating the subgrade wall waterproof membrane.
   vi. If Demonstrate the phasing required to account for hydrostatic uplift issues. For example: how much of the building needs to be constructed prior to turning off the dewatering pumps?

2. Shoring

a. **Water Table.** At shoring for structures located below the water table, locate the shoring walls a sufficient distance outside the face of the permanent basement walls to allow for proper installation and inspection of positive-side waterproofing.
b. **Underpinning.** Soldier piles used as underpinning shall be jacked to a load as specified by the engineer of record to preload the piles to prevent settlement of the existing building.
c. **Voids Behind Lagging.** All voids behind lagging shall be filled prior to excavating subsequent lifts. Use material and method that will not interfere with the free drainage system.
d. **Top of Shoring.** Remove top of shoring system a minimum of 3 feet below finished grade. Also remove additional depth as required by the local municipality or adjacent property owner.
e. **Temporary Tiebacks.** De-stress all temporary tiebacks.

3. Slab On Grade

a. **Joints.** Provide joints in all concrete slabs on grade.
b. **Joint Spacing.** Provide control or construction joints on all column lines and at 20’-0” maximum spacing each way in between. Structural engineer to determine closer spacing requirements.
c. **Plans.** Show the location of control and construction joints on the plans.
d. Reinforcement. Reinforce with conventional reinforcing steel each way. Welded wire fabric is not allowed.
e. **Flatness.** Design and specify floors that are engineered and constructed to achieve the following minimum degree of flatness when measured in accordance with ASTM E 1155: Overall FF = 35, Localized FF = 25. Garage floors may be Overall FF = 25, Localized FF = 20.
f. **Levelness.** Design and specify floors that are engineered and constructed to achieve the following minimum degree of levelness when measured in accordance with ASTM E 1155: Overall FL = 25, Localized FL = 17. Garage floors may be Overall FL = 17, Localized FL = 13.
g. **Capillary Breaks.** Provide below slab capillary break at all slabs on grade. Provide additional details and groundwater collection and drainage systems as required for slabs on grade located below the ground water table.

4. Sub-Grade Walls

a. **Material.** Use only concrete construction. Masonry is not allowable.
b. **Wall Length.** Place below-grade building walls in lengths limited to 40 feet.
c. **Retaining Wall Joint Spacing.** Space vertical expansion joints in site concrete retaining walls no more than 20 feet on center. Show specific location of joints on the drawings.
d. **Weep Holes.** Provide 2-inch round weep holes at 10’-0” on center maximum spacing in site concrete retaining walls.
e. **Joint Details.** Include all types of joint details on the drawings.
f. **Waterstops.** Provide waterstops at all construction joints below grade.

5. Tunnels

a. **Wheel Loads.** Design bar grating and hatch at top of utility vault manholes to support HS 20 wheel loads.
b. **Future Loads.** Size all components for piping support racks for the maximum possible loads and forces taking into account future piping.

D. Structured Floors and Roofs

1. Typical Building Floors

a. **Penthouse Floors.** Design penthouse floors to support a live load of 75 PSF or the actual equipment weights, whichever is greater.
b. **Vehicle Loading.** Design areas where trucks, man lifts or other vehicles have access for a minimum of HS20 loading. Design for fire truck loading in all fire lanes and appropriate areas.
c. **Equipment Access.** Design platforms for equipment to provide adequate access for maintenance personnel. This may include the design of catwalks and ladders at or above the main platform level. Design team to coordinate with mechanical design consultant and UW facilities shops on where platforms are needed.
d. **Flatness.** Design and specify floors that are engineered and constructed to achieve the following minimum degree of flatness when measured in accordance with ASTM E 1155: Overall FF = 35, Localized FF = 25.
e. **Levelness.** Design and specify floors that are engineered and constructed to achieve the following minimum degree of levelness when measured in accordance with ASTM E 1155: Overall FL = 25, Localized FL = 17. Note that the use of FL on structured floors is limited to when the slab is still supported in its original as-cast position (still shored) and when the slab has no camber.
f. **Sleeves and Curbs.** Provide sleeve and/or curb at all floor slab penetrations.
g. **Future Loads.** If a floor is designed for a future load, indicate clearly on the plan (or a key plan) the location, footprint, operating weight and move-in pathway as applicable. This may typically apply to future medical or lab equipment.

h. **Shrinkage.** Limit the shrinkage to 0.00030 inches per inch (including all admixtures) in the concrete in garage floor framing. The contractor shall submit shrinkage test results of mix, conducted per ASTM C-157, a minimum of 4 weeks prior to use.
i. **Garages.** Garage floors may be Overall FF = 25, Localized FF = 20.
j. **Pedestrian Bridges**. Design pedestrian bridges to support a minimum live load of 100 PSF. Also coordinate with Project Manager for any equipment loads that may be used on the bridge.
k. **Electrical Rooms.** Design slabs over electrical rooms with micro silica concrete mix or limit shrinkage to 0.00030 inches per inch and add polypropylene fibers. Treat all cracks with Methylmethacrylate.
l. **Post-Tensioned Slabs.** In post-tensioned slabs, provide for a method of permanently identifying each tendon's location on the soffit of the structure for future remodels. Identification shall be a maximum of 10 feet oc. Possible method is by use of ¾" chamfer strips on soffit of forms. Discuss with Project Manager and Engineering Services.
m. **Floating Slabs.** Avoid using "Floating Slabs" i.e., slabs that are acoustically isolated from the structural slab with insulation between the two slabs. These slabs are usually constructed before the building is "closed in" or protected from rain. Consequentially they are exposed to rain which saturates the insulation, making the acoustical performance ineffective and providing a breeding place for mold and mildew. Consult with Engineering Services if floating slabs are considered.

2. Laboratory Building Floors

a. **Live Loads.** Design all floors in new laboratory buildings to support a live load of 100 PSF. In addition, use 30 PSF for equipment load plus 20 PSF uniformly distributed partition load. Do not reduce the live load in the design of the floor slabs, floor beams and floor girders. Consider the equipment load as a live load.
b. **Columns and Footings.** Design the columns and footings to carry the 100 PSF floor live load reduced in accordance with the current building code. Do not reduce the equipment or partition loads.
c. **Shrinkage.** Limit the shrinkage to 0.00030 inches per inch (including all admixtures) in the concrete in the floor framing. The contractor shall submit shrinkage test results of mix, conducted per ASTM C-157, a minimum of 4 weeks prior to use.

3. Vibration

a. **Framing Scheme.** Some buildings on campus contain research instrumentation that is extremely sensitive to vibration. The structural engineer shall select a framing scheme as well as the size and spacing of columns to keep the floor vibrations within the criteria established for the project.
b. **Maximum Vibration.** Basic design is 2000 micro-inches/sec. maximum for lab areas. Refer to building program for more restrictive vibration criteria. Areas of some buildings may require 1000 micro-inches/sec. maximum. Use a walking speed of 100 steps per minute minimum.

4. Roofs

a. **Slope.** Slope the structural roof system to accomplish the roof slopes shown on the drawings. This applies to plaza decks and walkways also.
b. **Snow Load.** Design for a minimum Snow Load of 25 PSF.
c. Flatness. Design and specify roofs that are engineered and constructed to achieve the following minimum degree of flatness when measured in accordance with ASTM E 1155: Overall FF = 25, Localized FF = 20.
d. **Levelness.** Design and specify roofs that are engineered and constructed to achieve the following minimum degree of levelness when measured in accordance with ASTM E 1155: Overall FL = 17, Localized FL = 13. Note that the use of FL on roofs is limited to when the slab is still supported in its original as-cast position (still shored) and when the slab has no camber or slope.
e. **Camber.** Camber structural system as needed to assure positive flow of rainwater. Check for progressive deflection due to ponding.
f. **Dead Load for Re-Roofing.** Design with additional dead load to allow for reroofing once.
g. **Roofs as Future Floors.** If the roof is to be designed as a future floor, detail tops of columns and walls above the roof level for ease of future vertical extensions and to minimize the disturbance to the existing roofing. Clearly indicate on the drawings the extent of future addition that is designed for.
h. **Rooftop Platforms.** Design rooftop elevated platforms for equipment to provide adequate access for maintenance personnel. This may include the design of catwalks and ladders at or above the main platform level. Design team to coordinate with mechanical design consultant and UW facilities shops on where platforms are needed.
i. **Bracing of Rooftop Equipment.** Design for bracing of fume hood exhausts and other items that project above the roof including towers, antennas etc. Arrange guy wires and supports in a manner to minimize aesthetic disturbance.
j. **Window Washing Equipment and Fall Arrest Anchors.** Design for all window washing equipment and fall arrest anchor support.

E. Structural Materials

1. Concrete

a. **Strength.** Concrete strength shall be not less than 3,000 psi at 28 days.
b. **Dowels.** Dowels shall be provided at each construction joint to lap with all reinforcing in the adjoining member. This includes: each curtain of wall reinforcing, top and bottom slab and beam reinforcing, and all column reinforcing.
c. **Slab Temperature Steel.** Slab temperature steel shall be provided each way throughout all slabs. Provide each way top and bottom for slabs greater than or equal to 8" thick.
d. **Concrete Fill Over Steel Deck.** In structural steel construction with steel deck and concrete fill, specify a minimum of #4 @ 12" oc top over steel members that are parallel to the steel deck.

Extend bars a minimum of 2'-0" beyond the edge of the member flange. This will mainly occur over steel girders.

e. **Concrete Chart.** Provide chart on the structural drawings that clearly indicates each type of concrete used on the project. Include the following minimum information: strength, minimum cement content, maximum Water/Cement (W/C) ratio, air-entraining requirements and where each type of concrete is to be used.
f. **Water/Cement Ratio.** Specify low water/cement ratio for concrete to reduce potential shrinkage cracks.
g. **Ramps.** Use silica fume in concrete for all ramps greater than or equal to 5% grade.
h. **Epoxy and Powder-Driven Fasteners.** Epoxy and powder driven type fasteners are not allowed for tension applications.
i. **Curing.** Curing compounds are not allowed on slabs in laboratories and mechanical rooms and slabs over electrical rooms. Provide water curing only.

2. Reinforced Masonry

a. **Below-Grade.** Do not use masonry below grade.
b. **Control Joints.** Provide control joints in CMU walls and expansion joints in multi-wythe brick walls at a spacing not to exceed 1 ½ x the wall height or 25'-0" whichever is less. Provide vertical and horizontal reinforcing in CMU walls. Wall reinforcing shall not be less than #5 at 48" oc vertical and 2 #4 in horizontal bond beam at 4'-0" oc.
c. **Exterior Wall Metal Accessories.** At exterior walls, all metal accessories shall be stainless steel.

3. Steel

a. **Connection Design**. All connections are to be designed by the engineer of record. Fabricator designed connections are allowed.
b. **Open Web Steel Joists.** Use of open web steel joists is acceptable only for roofs in areas that are not supporting rooftop or suspended units greater than 400 pounds operating weight. Do not utilize open web steel joists to support fall arrest anchors, or loads from fall arrest anchors. Do not utilize open web steel joists for floor construction.
c. **Steel Decking.** Steel decking may be used for garage construction as a form only. Provide reinforcing bars (not WWF) in slab to support 100% of the design loads.
d. **Structural Steel Fabricator.** Structural steel fabricator shall be an AISC-Certified Plant Category Standard (Std). As an alternate to this requirement, the contractor shall pay for full-time inspection during the fabrication of the project steel. This inspection will be conducted at the fabrication plant by the owner's inspection agency.
e. **Button Punching of Side Lap Connections.** Button punching of side lap connections of steel roof deck (where no concrete topping) is not allowed. Provide welded, screwed, or other means to connect side laps.

4. Timber

a. **OSB.** OSB (oriented strand board) is not allowed for floors and roof.
b. **Gluing.** Glue all floor sheathing with minimum 3/16" diameter continuous bead of construction adhesive. Use two continuous beads at abutting panels.

Mechanical

A. Design Criteria and Campus and Power Plant Central Utilities

Programming

1. Provide equipment access pathways large enough to allow for the removal of coils and other large pieces of equipment. Identify these areas on the design drawings.
2. Include an evaluation for building system renovation projects which describes the condition of the building systems, variances from present codes, and identifies spare system capacity or system deficiencies and opportunities for improving energy efficiency. The design team's mechanical, electrical, civil, structural, and architectural disciplines participate jointly in this evaluation.

Design Criteria

1. Provide the basis of design including design parameters and analyses for the following:
   a. Connection to existing utility distribution systems, including capacity and location,
   b. Temporary construction water and sewer point of service,
   c. Distribution concepts including piping and ductwork,
   d. Load calculations for campus utilities,
   e. Seismic bracing for mechanical equipment, piping and ductwork,
   f. Special systems design (research and diagnostic equipment, and other equipment and designs not specifically covered by the FDS),
   g. Control systems and indoor environmental monitoring,
   h. Indoor dry bulb temperature,
   i. Indoor relative humidity,
   j. Outdoor dry bulb temperature,
   k. Outdoor wet bulb temperature,
   l. Occupancy, hours, and degree of activity,
   m. Ventilation – recirculation and outside air,
   n. Internal loads,
   o. Special loads,
   p. Insulating R-values for roof, wall, glass, etc.,
   q. Percentage of glass – fenestration,
   r. Type of glass, including coatings and solar coefficients,
   s. Building pressurization and infiltration,
   t. Building mass,
   u. Code requirements and impact on criteria,
   v. Air quality design criteria, i.e. ASHRAE 62, current edition
   w. Noise criteria,
   x. Building energy consumption and energy source,

y. Life cycle cost analysis for mechanical systems.
z. Sustainability,
aa. Maintainability.
bb. Redundancy
cc. Future Capacity
dd. Standby Power
ee. Fire and Life Safety

2. Design systems and components with maximum reliability, maximum flexibility, and minimum operation and maintenance cost. Give full consideration for future system alterations with a minimum of system shutdowns. Accomplish preventive maintenance without a major building shutdown. Maintenance accessibility is very important. Meet current regulations for worker safety, including fall protection.
3. Since laboratory buildings need periodic renovation to keep up with changing technology, divide the building up into lab modules. These lab modules are a basis for HVAC and plumbing zoning.
4. Provide isolation valves and devices for each utility serving each lab. Down feed all mechanical systems except the waste lines to minimize the number of floor penetrations.
5. Coordinate mechanical equipment located on the roof with the Architect. Minimize the number of roof penetrations.
6. Provide an acceptable means of accessing major equipment that needs to be maintained on a regular basis without the use of a portable ladder.
7. Provide access with platform for shafts that contain systems that require periodic maintenance, repair, or replacement, e.g. valves, dampers, and actuators. Provide accessibility where space is required for future mechanical equipment. Provide access through access doors or removable walls and space within the shafts. Sheet rock walls are considered removable. Accessible shafts are preferred over removable walls. Coordinate access method and platform requirements with Architect.
8. Mount equipment, e.g. fans and pumps, on a 4-inch thick concrete pad secured to structural slab. Size concrete pads larger than equipment. Extend the pad at least ten times the diameter of the mounting bolts past the equipment. Coordinate with Structural Engineer for final design.
9. See Architectural Finishes section for coating over entire mechanical room floor, including over housekeeping pads under air handling units, etc.
10. Provide galvanized schedule 40 pipe sleeves or manufactured through-penetration firestop devices for all piping penetrations through concrete and masonry. Coordinate with architectural and structural for location and installation.

Inter-discipline Coordination

1. Coordinate the mechanical work with other disciplines to define the work and responsibilities of the Mechanical Contractor. Because of the space taken up by the mechanical equipment coordinate the required infrastructure with all elements of the building to include architectural, structural and electrical. In many cases, the mechanical and electrical system space requirements necessitate changes to the floor plans, building sections, and exterior elevations, if not properly coordinated at the onset.
2. Align the mechanical shafts to minimize offsets.

3. Coordinate between the Mechanical Engineer and Electrical Engineer for equipment motors, motor starters, disconnect switches, thermal overload switches, variable frequency drives, and mechanical controls for all mechanical equipment including AHUs, exhaust fans, and pumps.

Operational Constraints

1. Sustainability, operability and maintainability are key elements in the evaluation of the Technical Program and Schematic Design. General use buildings are operated to match occupancy and are normally shut down during nights (10pm to 6am), weekends and holidays. Libraries usually have extended schedules. Laboratory buildings normally run continuously to maintain a safe working environment 24 hours per day. Evaluate on a building-by-building basis; to allow a more efficient operation.
2. In remodel or renovation projects, shutdowns of existing utilities and services may be necessary. These shutdowns may have to occur after normal working hours to prevent interruption of critical operations. Temporary utilities may be necessary to maintain service to critical loads in laboratories and hospital health care areas and to refrigeration equipment.
3. Locate equipment, valves, and accessories above ceilings such that they can be readily accessed within arm's reach by a person standing no higher than the second highest step on a stepladder of a height that fits below the ceiling. Coordinate ladder placement to avoid interference from casework, lab benches, sinks, adjacent walls, or lab equipment. Give consideration to ceiling tiles immovable due to sprinkler heads, light fixtures, or other ceiling mounted devices.

Construction Requirements

1. Include a statement in the specifications that all components of the ventilation system (e.g. fan, duct, insulation, sound attenuators, terminal boxes, etc.) must be kept clean and dry as manufactured, delivered, stored and installed before operating the HVAC system. At the University of Washington Medical Center and specific animal care facilities, confirm if isopropyl alcohol wipe-down is required at all air handling equipment prior to installation.

Renovation and Demolition

1. The abandonment of existing equipment and material in place is not acceptable. Conserve space as much as possible.
2. The correction of existing mechanical problems and removal of abandoned mechanical equipment, while maintaining the operation of the building, all need to be addressed in the contract documents.

Power Plant Central Utilities

Distributed utilities are generated at the Central Power Plant (CPP) and the West Campus Utility Plant (WCUP). Distributed mechanical utilities at the CPP include steam and steam condensate, chilled water, and compressed air. The WCUP generates chilled water only.

Steam and Steam Condensate

Steam is distributed from the Central Power Plant (CPP) to the campus buildings through the utility tunnel system. The primary use of the steam is for campus building heat. Other uses are Power Plant boiler auxiliary equipment, building service water heating, kitchens, humidity control and sterilization at the UW Medical Center and campus laboratories.

Steam is generated at 425 psi at the Power Plant to operate the turbine generator. Steam is extracted from the Power Plant steam turbine and distributed to the campus at 185 psi. The Power Plant also generates steam at 185 psi to supplement the steam provided by the turbine. Exhaust steam from the steam turbine at 10 psi is also distributed to the campus.

Each of the two steam pressure distribution systems is provided in a looped tunnel configuration as much as practical to provide service to the buildings. The loop configuration makes it possible to shutdown steam service from one side of the loop for maintenance or new construction connections while the other side of the loop remains in service to the buildings.

High temperature condensate is collected throughout the utility tunnel system where the 185 psi steam releases its energy and flashes. Low pressure steam generated from flashing is piped to the 10 psi steam system in the tunnel or in nearby buildings.

After the steam releases its energy and transitions into condensate, it is collected as much as feasible. The condensate is either pumped or returned by gravity to the Power Plant for steam generation.

Central Cooling Water (CCW)

Two utility plants supply CCW to the system:

The Central Power Plant (CPP) generates nominal 12,000-tons cooling capacity using five 2,000-ton centrifugal chillers, one 1,000-ton centrifugal chiller, and one 1,000-ton absorption chiller plus associated cooling towers and pumps. CCW-CPP operates seasonally from approximately early April through early October. CCW-CPP provides a source of higher temperature unconditioned condensing water during winter months when the chillers are off.

West Campus Utility Plant (WCUP) provides process cooling water with 3000-tons N+1 cooling capacity (with space for future build out up to 9000-tons N+1) using three 1,500-ton centrifugal chillers plus associated cooling towers and pumps. WCUP operates year around.

Each plant delivers central cooling water to interconnected distribution piping with manual isolation valves for separating the plant’s service sections.

Delta P Valves are required at each cooling coil or heat exchanger to set flow limit to maintain high return differential temperatures to the chillers. No substitution allowed.

Compressed Air

Compressed air is generated at the Central Power Plant (CPP) by three air compressors with a total nominal capacity of 6000 ACFM. The compressed air is distributed as a central utility from the CPP to campus buildings primarily through the tunnel system. The distribution service pressure is 100 psig. Before the compressed air leaves the Plant it passes through a desiccant air dryer system to a dew point of 40 degrees F. If drier air is required for use in the buildings then an air drier should be provided in the building.

The primary use of compressed air on campus is for the building environmental control systems. There are many campus buildings with pneumatic controls that are still in operation. Many of the new and renovated buildings have been outfitted with Direct Digital Control (DDC) systems. These buildings with DDC systems still utilize compressed air for operating large pneumatic control valves and damper actuators. Other uses for compressed air on campus include fire protection dry pipe systems, fire smoke damper actuators, automatic door openers, and teaching and research laboratories.

Air Handlers

1. Include double-walled panels in air handlers with a minimum of 2 inches of fiberglass insulation, 16 gauge exterior galvanized steel; and 22 gauge internal galvanized steel perforated except downstream of cooling coils and in outside air intakes.
   a. Floor: non-skid floor that extends up the walls to prevent leakage in the event of water accumulation.
   b. For access doors, use the same metal gauges and insulation levels as are specified for the rest of unit.
   c. Downstream from cooling coils, double-walled internal duct insulation with a solid metal surface exposed to the air stream is required.
2. Provide galvanized angle iron bracing inside plenums.
3. Provide access doors to each area between the coils, filters and fan. The access between the coils, filters and fan must be a minimum of 18 inches (preferably 24 to 36 inches).
4. Fan array must include individual backdraft dampers at each fan.

Fume Hood Fans

1. Provide access for fan maintenance.
2. Mount the fan with vibration isolators.
3. Installing fans in a penthouse is preferred. Provide weather protection for fans installed outdoor.
4. Locate the fan as the last element of the system to assure that the ductwork throughout the building is under negative pressure.
5. Install fans to be readily accessible for maintenance and inspection without entering the plenum. If exhaust fans are located inside a penthouse, consider the ventilation needs of maintenance workers.
6. Discuss fire alarm interlocks to fume exhaust fans and standby power requirements with EH&S and Engineering Services.
7. Specify fume exhaust fans with minimum two belt sheaves.
8. Provide ball-type fan bearings (selected for extended life), lubricated with grease fittings extended through fan casing for easy access.

9. Provide each fan drive with an easily removable guard assembly protecting drive belts and shaft, with access for tachometer use.
10. Specify all belt guards to allow visual inspection.

Fume Exhaust Fans

1. Provide fans with the following:
   a. Outboard "split" bearings,
   b. Shaft seal,
   c. An access door,
   d. Multiple 150 percent rated belt drive. In designing for explosion and fire control, provide fans with non-sparking construction and non-conductive V-belt drives.
2. Provide chemical resistant fan system.
3. Weld or permanently seal fan housing to avoid air leakage from the wheel shaft and discharge.
4. Fume exhaust fans to have arrangement 1 or 9, overhung wheel type with bearings outside air stream. Fans to have two bearings; split-case with split inner and outer races and cage.
5. Choose fan type as follows:
   a. Use straight-radial fans for systems handling moderate to heavy quantities of particulate matter in air.
   b. Use backward-inclined fans for systems handling relatively clean (low particulate) air.

Perchloric Acid Hood

1. Provide an induction type fan for perchloric acid hoods.
2. Provide perchloric acid systems, including duct fans and hood, with an internal wash-down system that meets the following requirements:
   a. Design the perchloric acid fume hood system to provide as complete a wash-down with all ductwork at 45 degrees or less from vertical to drain back to the fume hood.
   b. Provide fan casings and hood bottoms with continuous gravity drainage to the acid resistant waste.
   c. The wash down system to include a manual valve located adjacent to the fume hood.
   d. Prior to substantial completion, testing of the wash-down system to be witnessed and approved by Owner’s witness and EH&S.

Installation, Fabrication and Construction

1. During storage, transport, and installation prior to start-up, cover the air handlers with plywood and/or plastic as necessary to keep them dry, clean, and protected from damage. Provide heaters and/or dehumidifiers if necessary to prevent condensation inside air handlers prior to start-up. Provide temperature/humidity data loggers in units in transit and during storage. Air handlers with insulation that has been wet are unacceptable.
2. Thoroughly clean equipment casings of debris and small particles of rubbish and dust before installing and making final duct connections.

3. Do not start the fans until the Owner has approved the level of cleanliness of the air distribution system. Provide full access to the system for the inspection of cleanliness prior to start-up.
4. The preferred fan design is single inlet, single width centrifugal type with backward inclined airfoil blades; however, utilization of airfoils, propellers, and duct axial flow fans is acceptable where appropriate.
5. Do not provide VFDs on manifolded fume exhaust systems unless a minimum of 2500 fpm exit stack velocity can be maintained. Refer to section Mechanical – Testing, Adjusting, and Balancing for balancing information related to VFDs.
6. Provide rigid structural steel base for both fan and motor with slide rails for drive adjustment. Hinged motor bases are not acceptable.
7. Avoid operating HVAC systems prior to the completion of construction except where flushing of the building is necessary to comply with LEED requirements.
8. After construction dirt has been removed from the building, provide new filters for permanent locations.
9. Indicate the required filter removal and equipment access space on the contract documents.

Heating Ventilation and Air Conditioning

B. Building Chilled Water Systems

Building Chilled Water applies to one or more of the following systems:

- Central Cooling Water (CCW)
- Process Chilled Water
- Environmental Chilled Water

Programming

1. Some lab equipment may require a decoupled primary/secondary loop to accommodate high pressure drops and internal condensation.
2. Give special consideration to the location of cooling towers with respect to contamination of the building fresh air intake, intakes of nearby buildings and noise to the occupants and local residential areas.
3. If a building is connected to the Central Cooling Water (CCW) system, provide a heat exchanger and secondary pumping system to decouple from the CCW utility.
4. Size the chiller(s) with sufficient capacity to accommodate estimated future loads. Incorporate capacity control strategies to limit short-cycling and provide efficient operation during present and future loading.
5. Provide redundant capacity for the process chilled water system where a shutdown is not tolerable.
6. As a general practice, do not provide mechanical cooling in general use buildings, except for libraries and large auditoria. Buildings may need ambient and/or process cooling. Provide ambient cooling to maintain the ventilation air temperature. Provide process cooling to meet equipment loads.

Design Criteria

1. Establish project design criteria for the following items:

    a. Chiller type,
    b. Chiller refrigerant type and quantity in pounds; refrigerant machinery room calculation; see Refrigeration section,
    c. Cooling tower type,
    d. Cooling tower air intake and discharge locations,
    e. Cooling tower chemical treatment system,
    f. Equipment location,
    g. Reliability of the system, i.e. quantity of equipment for maintenance and repair work,
    h. Humidity requirements,
    i. Future system expansion provisions,
    j. Special equipment cooling requirements, e.g. lasers,
    k. Chiller room alarm monitoring and ventilation,

   l. Carbon footprint.

2. Provide equipment with weatherproof enclosures and screening if roof mounting is required.
3. Size the chilled water distribution piping for the ultimate load based on 4 feet/second nominal velocity.
4. Provide a supply air temperature of 60° F for buildings cooled by the CCW System.
5. Calculate system differential pressure based on anticipated pressure drop for existing and future equipment. For process chilled water loops, base the system pressure on equipment differential not less than 30 psi. Locate the differential pressure controller two thirds of the distance to the most distant point of the system.
6. Depending on the level of reliability required for the system, the following equipment may need to be on the emergency power for non-life safety systems. Coordinate with UW Project Manager.
   a. Chilled water circulating pumps,
   b. Chillers,
   c. Tower fan and condenser water circulating pumps,
   d. Controls.

All additions to the emergency power for non-life safety systems must be discussed with Engineering Services.

7. Locate water-cooled chillers in the basement mechanical room for the best vibration isolation situation.
8. Provide lead-lag pumps for both the chilled water and condenser water systems.
9. Use glycol to prevent freezing of condenser or chilled water coils exposed to freezing outside air.
10. Provide an expansion tank fitted with automatic fill and drain for the chilled water system.
11. Provide controls that prevent the chiller from operating unless chilled water pump, condenser water pump, condenser fan, etc. are operating.
12. Provide Flow/No-Flow switches to verify pump operation and use heat dissipation of the chilled water or condenser water to sense flow.
13. Provide access platforms as required for maintenance of rooftop-mounted cooling towers or chillers.
14. The central equipment for ambient cooling is located in the power plant and includes both steam absorption and electrical centrifugal chillers to meet the load.
15. Provide make-up water and blowdown/drain meters for cooling towers. See Meter Section for information.
16. Chemical treatment systems for cooling towers are preferred over non-chemical water treatment systems. Please discuss with Engineering Services if a non-chemical treatment system is being considered.
17. Provide secondary containment and an eyewash and safety shower for cooling tower chemical storage areas.

CCW-CPP Design Criteria

1. The CCW-CPP System operated as a primary pumping system with pressure differential manually controlled at the CPP. Additional controls located at the building control the building differential pressure.
2. The CCW-CPP System temperature and pressure varies during the operating season. Use the following for design conditions:

Season	Nominal Supply Temperature, °F (at CPP)	Nominal Return Temperature, °F (at CPP)
Summer (early-May through early-October)	42 °F	56 °F
Winter (early-October through early-May)	Unconditioned (typ ~60-70 °F)	Unconditioned (typ ~60-70 °F)

3. During the winter months, a nominal flow of water is maintained through the CCW-CPP System. Provide each building with a winter/summer control switch as noted in detail Central Cooling Water Building Header and Coil Connection.

CCW-WCUP Design Criteria

1. The CCW-WCUP system operates as a primary pumping system with pressure differential automatically controlled based on a sensor near ARCF/Hitchcock. Additional controls located at the building control the building differential pressure.
2. The CCW-WCUP System temperature and pressure varies during the operating season. Use the following for design conditions:

Season	Nominal Supply Temperature, °F (at CPP)	Nominal Return Temperature, °F (at CPP)
All Seasons	42 °F CCWS @ 70° F OAT reset linearly to 52 °F CCWS @ 40 °F OAT; waterside	Variable, 14 °F ΔT

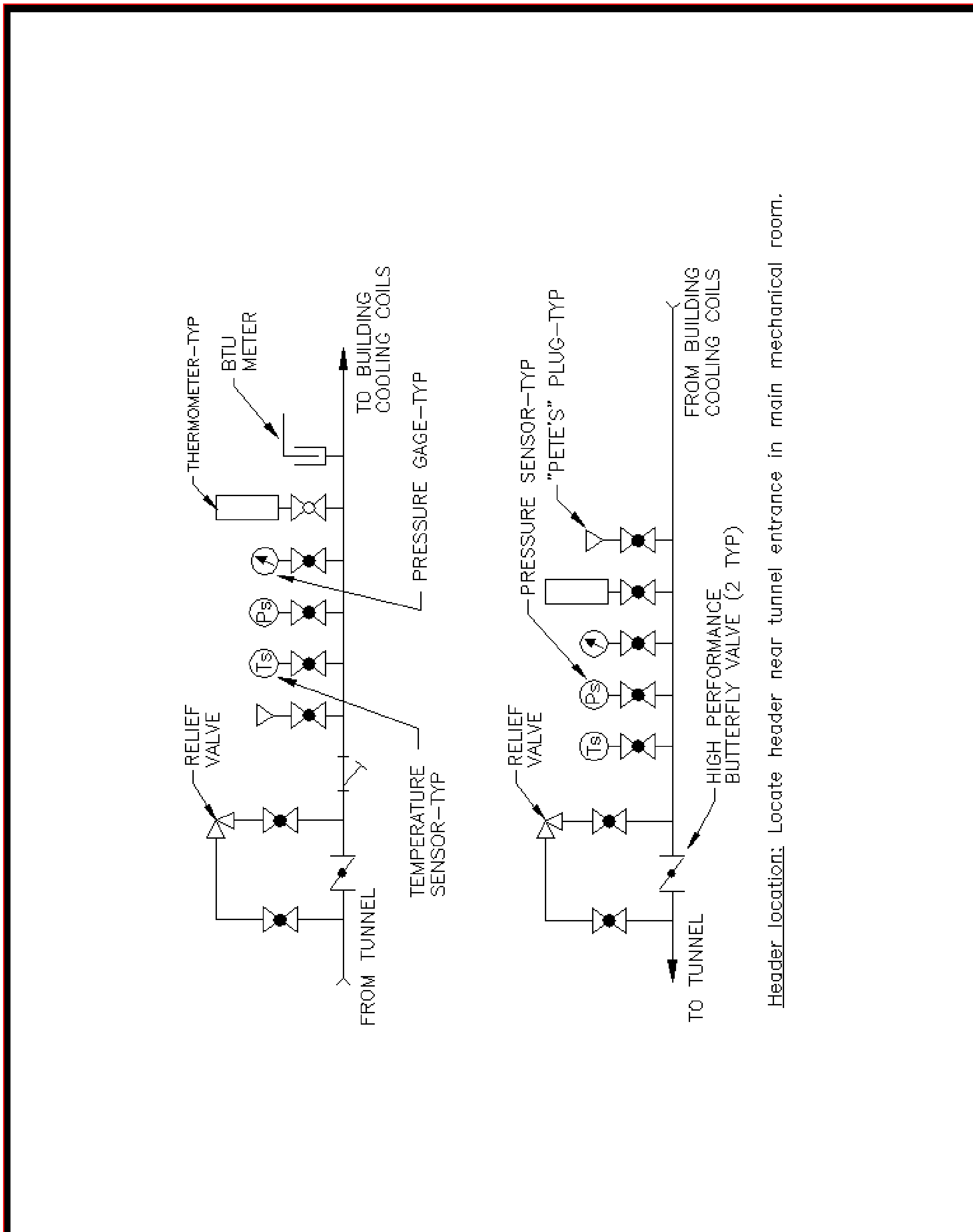
	economizer below 48 °F OAT	

CCW Header at Building

1. Locate the CCW header along a wall adjacent to the tunnel entrance at a convenient height for maintenance and repair access.
2. Each plant delivers central cooling water to interconnected distribution piping with manual isolation valves for separating the plant's service sections.
3. Delta P Valves are required at each cooling coil or heat exchanger to set flow limit to maintain high return differential temperatures to the chillers. No substitution allowed.
4. At each building CCW cooling coil or heat exchanger, provide a two way, pressure independent control valve, Delta P Valve as manufactured by Flow Control Industries, Inc., no substitutions.
5. A typical building header and coil connection is shown in the Central Cooling Water Building Header and Coil Connection detail at the end of this section. Provide the appurtenances such as bypass relief valves, pressure gauges, thermometers and isolation valves shown on this detail.
6. Pipe the bypass relief valves to relieve pressure from the building side of the isolation valve to the CPP side of the isolation valve. The valves relieve water when the differential across the relief valves exceeds 15 psig. Provide and fasten a metal nameplate to the valve to label the manufacturer, model and spring range. Cash Acme or Kunkel; no substitutions allowed.

Installation, Fabrication and Construction

1. Locate the chilled water loop for each floor in the corridor, easily accessible to all spaces. Locate isolation valves for each space in the most accessible area (either in the corridor ceiling space or inside the room.)
2. Provide isolation valves at all air vents.
3. Install expansion tanks with drain, air vent, and lockshield shut-off valve.
4. If two-way control valves are used, provide a 1-inch bypass line with globe valve for throttling at the most remote coil to allow continuous flow through the building piping.



FACILITY MANAGEMENT OFFICE PLANT ENGINEERING	STANDARDS DRAWING	DWN BY: JKM	
	CENTRAL COOLING WATER BUILDING HEADER AND COIL CONNECTION	APPR BY:	
		REV: B DATE: 12/13/13	
DATE: 6/13/00		SD–M–31	

C. Building Steam and Condensate

Design Criteria

1. Heat all buildings with steam from the power plant whenever feasible. Steam is available at 185 psig and/or 10 psig. Use 10 psig steam whenever possible because it benefits the operation of the power plant turbine generator. The 185 psig steam is reserved for use in buildings distant from the power plant (i.e., Campus Parkway and South Campus) and laboratory buildings that need the higher pressure steam for laboratory or process use. Provide local building two-stage pressure reducing stations to reduce the 185 psig steam down to 15 psig for use on all building heating systems. To meet varying load conditions provide pressure reducing stations with parallel 1/3 and 2/3 full load valves per stage. Pressure reducing stations shall be complete in every detail to include gate valves for isolation, strainer, drip trap and strainer assembly, relief valves, and pressure gages. Steam radiant heating is not acceptable except for special applications approved by Engineering Services.
2. Convert Power Plant steam to hot water at all buildings to meet all heating requirements except one-way air (100% outside air) system preheat coils. Use steam in one-way air system preheat coils to prevent freeze damage to the system. Provide two-position control valves on preheat coils in one-way air systems. Use low pressure steam, no greater than 15 psig; size the preheat coil based on 7 psig steam to the valve.
3. See Metering section for steam/condensate meter and monitoring requirements.
4. Recommended AHU coil arrangement in order from the outside air intake to the supply fan on a draw thru system is (heat recovery, steam preheat, heating water, and cooling coil). Discuss with Engineering Services if different.

Products, Material and Equipment

1. Provide inverted bucket-type traps at the end of high pressure steam mains. Provide float and thermostatic type traps for low pressure steam mains.
2. Provide pneumatic rather than self-contained steam control valves on hot water converters.
3. Hand valves for radiators or convectors should be packed type suitable for servicing.
4. Converters must be ASME approved, stamped, and State Boiler Inspector's certificate forwarded to University. Use low pressure steam only (15 psig maximum) with capacity based on 7 psig steam to the control valve.
5. Provide slip-type pipe expansion joints. Bellows type pipe expansion joints are not acceptable.
6. Provide 1” warmup bypass pipe with globe valve across all main building steam isolation valves and all tunnel steam isolation valves.
7. Orient steam piping and install steam traps to avoid accumulating steam condensate above vertically oriented steam shutoff valves.
8. Where inverted bucket traps are used, avoid traps that lose their prime during low load conditions then need to be manually re-primed.
9. Preferably, avoid use of noise reduction orifice plates at steam PRVs.
10. See Steam Trap Assembly detail at the end of this section.

Installation, Fabrication, and Construction

1. Provide steam headers with valved branches to each specific load, hot water, storage heater, converter, heating coil, etc.
2. Provide pressure reducing stations with at least two valves sized for 1/3 - 2/3 of total load. Show loads on drawings.
3. Flash high pressure steam (185 psig) condensate in a flash tank to the low pressure steam system.
4. Drip and trap all low and medium pressure steam (1 - 110 psig) supply main branches over 12 feet long.
5. Provide strainers ahead of traps on coils, converters, or other heat exchangers. Provide adequate static head (minimum 12”) above traps to insure proper operation.
6. Do not lift condensate by steam pressure.
7. Do not install steam or condensate piping below slabs on grade.
8. If steam is intended to be used for temporary heat, discuss with Engineering Services. For temporary heat, dump condensate to sanitary sewer by tempering to below 140°F.

D. Coils and Filters

Coils

1. Provide detail drawings of cooling coil drain pan traps. For AHUs, assure that condensate trap has sufficient depth to overcome fan static pressure and the height of the drip pan connection is sufficient for the trap to clear the floor.
2. Use condensate drain pan dimensions sufficient to catch all condensate off coil. Provide pan under coil and extend downstream of coil far enough to catch all condensate.

Filters

1. Provide MERV 8 pre-filters and MERV 13 final filters. Final filters shall have 85% efficiency (dust spot method using atmospheric dust)
2. Use 24 inch by 24 inch filters if possible.
3. Provide filters for specific applications (e.g. HEPA, grease).
4. Size filters at max. 500 feet per minute face velocity.

Products, Material and Equipment

1. Provide non-freeze type steam coils with perforated inner distribution tubes with vertical tubes; each section should be individually trapped. Tube wall thickness must be 0.035 inches (minimum).
2. For systems that require freeze protection, provide inhibited propylene glycol. Do not provide glycol feed system for closed loops.
3. At the high points in the water systems provide automatic air vents with a cast iron body, copper ball float and needle, or ball-type air valve. Provide manual air vents on zone heating coils. Provide low point drains on hydronic systems.
4. Provide a maximum fin density for coils of 10 fins per inch and tube wall thickness of 0.035 inches (minimum).
5. Locate and arrange air conditioning equipment for reasonable motor, filter, and coil/tube removal.

Installation, Fabrication and Construction

1. Provide a hose end drain valve on each water coil.
2. Locate all air heating and cooling coils so that water jet or steam cleaning may be employed on each side of each coil. Provide ductwork access panels on each side of each coil.
3. Provide a balancing valve in the return piping from each individual coil.
4. Provide isolation valves with rising stems or quarter turn valves at the inlet and outlet of each AHU or supply fan coil, or other major component. Locate valves so that each unit, and its control valve, can be serviced without draining an entire system or riser.
5. Provide access panels in ceilings or partitions for servicing concealed coils.
6. Provide a flow-measuring device such as a Venturi in the coil piping of each supply fan.
7. Indicate the required coil equipment access and removal space on the contract documents.

E. Computer Server Rooms

Basis of Design

In support of the UW's efforts to meet its climate goals and objectives, no new server rooms or upgrades are to be designed into new or existing buildings on any of the campuses of the University of Washington. A server room is defined as a separate or shared space used to store, power, and operate computer servers and their associated components in support of business functions. Business functions are all of the activities that support the work of the University, whether academic, administrative, research, or clinical in nature.

This policy is effective immediately and applies to all University campuses, schools, colleges, and departments, including those in partnership with the University through affiliations, and third-party entities operating in University facilities. Campuses, schools, colleges, and departments are henceforth directed to work with the UW Information Technology (UW-IT) unit on solutions for meeting technology requirements.

University policies, standards, guidelines, and procedures institute controls that are used to protect and operate University assets and resources efficiently and effectively. While every exception to a policy or standard weakens the overall efficiency goals and intent of the policy, occasional exceptions may be necessary. See UW Administrative Policy Statement 17.1 which defines the process for the review, approval, and time limit of exceptions to this policy statement.

If the exception is granted, please contact Engineering Services to obtain FDS section that outlines design criteria for computer server room design.

F. Refrigeration

Design Criteria

1. Provide design criteria and calculations for refrigeration system, including the following items:
   a. Refrigerant type
   b. Calculated refrigerant quantities of refrigerant machinery room, all rooms served by the refrigeration system, and all rooms with refrigerant piping routed through rooms.
   c. Identify rooms with refrigerant that exceeds quantity threshold per code
   d. Provide scheme for warning and exhaust systems to comply with code requirements
2. Design air-cooled condensing units using an ambient temperature of 95 º F. Design to operate at a low ambient temperature of 0º F.
3. To improve efficiency and avoid short-cycling, incorporate a compressor capacity-control scheme; such as hot gas bypass or multiple compressors staging With the exception of refrigeration systems that incorporate heat recovery.
4. Allow sufficient ventilation for air cooled condensing unit heat rejection. Do not install units in an enclosed space.
5. Regulate condensing unit fan speed to control the condensing system operating pressure. For multiple fan units, regulate the fans on a "first on last off" basis.
6. Provide compressors located remotely from evaporators with oil separators. Design oil circulation piping to ensure adequate oil circulation.
7. Install refrigeration compressors, condensers, and condensing units in a mechanical room or in a weather-protected enclosure.
8. Provide evaporator condensation drains with a trap and route to funnel or floor drains. Provide condensate pan and piping with insulation.
9. Implement the "pump down" method to control compressors. Provide compressor controls with a low-pressure switch, primary control and a high-pressure limit with manual reset. Provide compressors designed with pressurized oil lubrication which have an oil pressure safety switch with timer and manual reset.
10. Provide a minimum of 400 cfm per ton for evaporator units.
11. Fluorocarbon refrigerant R-22 is not acceptable. Eliminate all CFCs from existing facilities. Provide EPA approved HFC refrigerant for new equipment (if not available, discuss with Engineering Services). CFC and HCFC are not acceptable.
12. Size Variable Refrigerant Flow (VRF) systems small enough to avoid classifying non-communicating spaces as refrigerant machinery rooms.
13. Where a refrigerant machinery room is required, design as follows:
    a. Refrigerant leak detection system must be per Preferred Vendors list.
    b. Locate refrigerant leak detection panel inside the Refrigerant Machinery Room, with at least one remote panel connected to that system located outside the main entrance to the Refrigerant Machinery Room. If remote panel is located in an accessible common area, install

panel in lockable cabinet. Consult with Engineering Services for key number to be used on lockable cabinet.

c. Refrigerant leak detection system must be compatible with the Fire Alarm System and the Building Automation System.
    i. The Fire Alarm System monitors status of the Leak Detection System for alarm and trouble (including loss of power) conditions.
    ii. During normal operation, the Leak Detection System commands the ventilation system to normal occupied airflow rate.
    iii. Upon an alarm signal at the Leak Detection System, the Leak Detection System commands the ventilation system to the emergency airflow rate. Transmit an alarm signal to Fire Alarm Panel and the Building Automation System. The audible and visual alarms are activated
    iv. The Fire Alarm System and the Building Automation System monitor normal speed fan(s) status via current sensing relays. During failure of fan(s) to operate at normal speed in normal mode, generate a supervisory signal at both the Fire Alarm System and the Building Automation System. Fans shall default to the emergency airflow rate. The audible and visual alarms are activated.
    v. The Fire Alarm System and Building Automation System monitor emergency speed fan(s) status via current sensing relays. During failure of fan(s) to operate at emergency airflow rate in emergency mode, generate a supervisory signal at the Fire Alarm System. The audible and visual alarms are activated.
    vi. The Fire Alarm System monitor leak detection panel status via trouble contact. During failure of leak detection panel, generate a trouble signal at the Fire Alarm System. Upon panel failure, fan(s) default to emergency airflow rate. The audible and visual alarms remain inactivated.
d. Legally required standby power must be supplied from UW Emergency Power System.
e. Leak detection system alarm level must be set to the refrigerant's Permissible Exposure Limit (PEL). Where calibration gas is not available at the PEL, set the alarm level for the lower calibration gas level. For example, adjust the set point to 900-ppm when the PEL is 1000-ppm, if 1000-ppm calibration gas is not available.
f. Locate refrigerant audible and visual alarm devices outside each refrigerant machinery room door and within the refrigerant machinery room as per ASHRAE 15/34 and NFPA 72. Audible alarm devices to have a continuous tone. Visual alarm devices to have blue acrylic light covers.
g. Provide all refrigerant audible and visual devices with signs permanently hung below the device(s). Signs must be three-layer etched plastic with white letters on a blue background. Letters must be a minimum of 1/2" high.

Signs within the refrigerant machinery room must read:

WHEN FLASHING

REFRIGERANT LEAK / NO FAN

EXIT SPACE

Signs outside each refrigerant machinery room entrance must read:

WHEN FLASHING

REFRIGERANT LEAK / NO FAN

DO NOT ENTER SPACE

h. Refrigerant machinery room systems must be commissioned, with a written functional test procedure reviewed by Engineering Services developed to ensure the system is calibrated and tested per design. The functional test will be witnessed by Engineering Services and Fire Alarm Shop.

Products, Material and Equipment

1. Provide maximum warranty option for compressors.

Installation, Fabrication and Construction

1. Braze all pipe joints under a nitrogen purge. No mechanical couplings allowed. No Flare connections.
2. All work must be performed by a contractor with a valid City of Seattle Refrigeration Mechanics license. A & B Refrigeration Handlers Certificate with a Universal Rating are also required where applicable.
3. Subject completed systems to the field test as stipulated in the latest edition of the Seattle Mechanical Code. The University's Representative must witness this test.
4. Complete Refrigeration Compliance Forms. The University can provide these forms or download from https://www.washington.edu/facilities/fstech/node/609.

G. Ductwork and Duct Pressure Testing

Design Criteria

1. Select duct velocities to meet N.C. requirements of each occupied space. NC level requirements to be identified in the Basis of Design narrative. Coordinate required NC levels with University Project Manager and users.

Supply, Return and Non Fume Exhaust Ductwork

1. Provide a 6-inch pressure rating for supply ductwork and plenums between the supply fan and the zone terminal boxes; for ductwork downstream of the terminal box, provide a 2-inch pressure rating.
2. Use the ASHRAE Handbook of Fundamentals chapter on duct design to determine the allowable leakage rate (cfm/100 sq. ft.) at the specified test pressure for each type of ductwork on the project other than fume exhaust ductwork. Specify for each type of ductwork the duct pressure rating, the pressure to apply during the duct leakage test, and the allowable cfm/100 sq. ft. leakage rate at the test pressure.
3. Minimize use of square elbows. Provide turning vanes in square elbows of supply ductwork. Do not use turning vanes in return or exhaust ductwork.
4. Do not use perforated plate ceiling diffusers in office or classroom applications. They cause drafts.
5. Specify laminar flow diffusers in laboratory applications when required.
6. Do not use nonmetal ductwork (i.e. fiberboard, fabric) without the approval of Engineering Services.
7. Design ductwork to and from the HVAC equipment so that stratified air is mixed properly before entering branch ducts or downstream equipment.
8. Limit flexible duct to no more than 6 feet and one elbow.
9. On renovation and remodel projects, provide a preliminary air balancing report with current and design airflows.
10. On renovation and remodel projects investigate the condition of existing duct liner, in particular at cooling coils. Test for mold and replace duct liner if warranted.

Dampers

1. To minimize noise, install manually operated, opposed blade or single blade, quadrant-type volume dampers on all branch main and branch duct takeoffs from the main duct to control the amount of air entering or leaving the branch. Locate those balancing dampers adjacent to the connection to the main branch.
2. Indicate balancing damper location for each outlet and each inlet.
3. Avoid register or diffuser-mounted dampers because they cannot reduce large volumes of air without causing objectionable air noise levels.
4. To minimize generated duct noise, locate volume dampers at least two duct diameters from a fitting and as far away as possible from the outlet or inlet.

5. Provide the necessary access space around components to allow the TAB technician to take proper readings. Allow adequate straight duct sections from fan outlets, elbows, or open duct ends to provide accurate duct traverse readings.

Pressure Relief Doors or Panels

1. Smoke/fire dampers have the potential to damage ductwork if they close by accident, or even if they close when the fan is shut off but wheeling down during a power outage, fire test, or fire. Risk of damage to the ductwork is particularly serious if a single smoke/fire damper can stop the full supply of air into or out of a large fan. Design the air distribution system so that the ducts won't be damaged if the fans are run with the smoke fire dampers closed.
2. The preferred means for protecting the ductwork against over-pressurization during smoke/fire damper closure is to select a duct pressure classification so the ducts can withstand sudden exposure to the maximum fan pressure. Provide accessible, well-sealed pressure relief doors or panels that can be closed after they open.
3. Use pressure relief doors rather than pressure relief backdraft dampers.

Mounting

1. For roof-mounted ductwork, fans and air handlers, see the architectural standard drawing titled Mechanical Equipment Mounting for minimum mounting height.

Renovation and Expansion Projects

1. When adding or removing ductwork on an existing air distribution system, show on the mechanical drawings all existing ductwork and flow rates required to be rebalanced after construction.
2. Review manufacturer's fan data for existing fans to ensure these fans can operate at the new operating conditions. Review existing motor amperage and motor nameplate to determine if a new fan motor is required.
3. In the fan schedules, provide the existing and proposed fan airflows, fan static pressures, motor amperages and motor horsepower requirements for existing fans serving systems altered in renovation projects. The existing actual flows are needed for the design. Arrange with the University of Washington Project Manager for flow measurements as needed.
4. On floor plans, show any new balancing dampers required in the existing branch ductwork to facilitate balancing.
5. Require measurements, prior to demolition, of any unknown airflows or static pressures required to be reestablished as part of testing, adjusting and balancing.
6. If a small portion of an existing system is to be changed, avoid creating a new high pressure drop critical path to an existing system. Select larger components to avoid significant increases in the fan discharge pressure requirements.
7. Provide temporary means as necessary for dust control and lab safety while ductwork and fans are being removed and installed.

Fan-powered Zone Air Terminal Boxes

1. For VAV air terminal box fans, specify the method of speed adjustment (e.g., continuous or 3-speed fan control) to be used during testing, adjusting and balancing. In reviewing manufacturer's literature during design and during contractor equipment submittals, make sure the selected air terminal boxes operate at a speed range that doesn't create excess noise or motor problems. Specify "extra-quiet" fan-powered VAV boxes.
2. Specify maximum sound ratings (db. level) for the air terminal boxes.
3. To control sound transmission out of the secondary (plenum) air intake, include a lined intake boot that has at least one 90 degree elbow.
4. On mechanical floor plans, indicate with dotted lines the horizontal access clearance requirements for maintenance of air terminal boxes.
5. Connect fan powered air terminal boxes to the ductwork with flex connections.
6. Connect fan powered air terminal boxes to structure with vibration isolators unless the fans are internally isolated.

Smoke/Fire Dampers

1. The smoke/fire dampers and their actuators are to be covered under the ductwork specialties section of the project specifications (not under controls or the fire alarm system). Exception: The EP switch for smoke/fire damper pneumatic actuators is specified under the fire alarm system. Coordinate with electrical and refer to Environmental Health & Safety Design Guide – Fire Alarm System section.
2. The University strongly discourages use of engineered smoke control systems. Consult EH&S before designing one.
3. Work with the Architect and EH&S to minimize the number of smoke/fire dampers through (1) coordination of duct layout with suite configuration, and (2) close attention to code "exceptions" to standard smoke/fire damper placement requirements.
4. Pneumatic actuators are preferred. If electric smoke/fire dampers are used, discuss actuator application including noise with Engineering Services.
5. Dampers to be Class II, 250° F, with a minimum closure time of 7 seconds and a maximum closure time of 15 seconds.
6. Fire damper actuating device to be rated at approximately 50° F above normal operating temperature within duct system. Rate for 286° F for smoke control systems.
7. All smoke/fire dampers must be self-resetting.
8. Provide end switch for position verification.

Access Doors and Panels

1. Coordinate with Architect to ensure there are access doors through walls and hard ceilings wherever necessary to reach access doors in the HVAC equipment.
2. Provide a minimum of 24" x 24" size access doors and panels unless the duct is too small to accommodate a larger door or the necessary access can be handled easily with a smaller door.
3. Coordinate with Architect so that all access doors and panels in the ductwork are accessible in a manner that meets applicable safety standards. This includes access doors and panels located at the smoke/fire dampers.

Hospitals, Labs, and Animal Holding Facilities Pressure Relationships

1. On hospital, lab, and animal holding facilities projects, discuss with EH&S and Engineering Services whether there are any special requirements for documentation and review of room pressure relationships.
2. See EH&S Laboratory Safety Design Guide.

Construction Submittals

1. For smoke/fire damper submittals: Include the number of damper actuators in each damper bank, and an equipment list showing the manufacturer, model number, and amperage draw for the actuators in each damper bank (whether composed of a single or multiple dampers).
2. Include manufacturer's literature on the smoke/fire damper actuators.
3. For projects with electric smoke/fire dampers, provide shop drawings that show electrical and mechanical coordination of smoke/fire dampers.

Products, Material and Equipment

Accessories

1. Provide insulated drip pans for cooling coils.
2. Damper position switches that contain mercury are not acceptable. Use cam action, lever, or proximity type damper position switches.

Ductwork – Non Fume Exhaust

1. Provide an easily accessible lockable, handle for each balancing damper. Orient the handle parallel to the damper blade(s).
2. Use aluminum sheet metal with watertight joints for exhaust ductwork from high humidity areas such as shower rooms. Slope ductwork back toward inlet.

Fan-powered Zone Air Terminal Boxes

1. Internally isolate the fans in air terminal boxes.
2. Line the air terminal boxes with at least 1 inch of fiberglass batt insulation. Cover liner with aluminum foil at least 0.001 inch thick to prevent entrainment of fibers into the air stream.
3. Damper shafts to have at least one flat facet at the point of connection to the actuator.

Damper Shafts

1. Provide a grooved scribe running parallel to the blades on the end of each damper shaft to indicate damper position.

Fume Exhaust Ductwork

1. See EH&S Laboratory Safety Design Guide.

Buried Fiberglass Reinforced Plastic (FRP) Ductwork

1. Submit design and calculations for buried FRP for review and approval.

2. Construct FRP per industry standards and manufacturer's recommendations.
3. Buried RFP thickness to withstand bearing loads from soil and structure above, in addition to any applicable ductwork suction pressure.
4. Provide counter weight and properly strap down buried FRP to resist buoyant force.
5. Compact soil to an unyielding state. Provide minimum 6" thick pea gravel underlayment and compact to an unyielding state prior to installing the FRP.
6. Ensure installing system free from unnecessary stresses.
7. Slope ductwork and provide drainage as needed.

Smoke/Fire Damper Actuators

1. Provide pneumatic actuators for the smoke/fire dampers unless the building doesn't have other pneumatic controls. (The Facilities Services Design Standard requires pneumatic actuators for HVAC controls in mechanical rooms. See the Environmental Control Systems section.)
2. Serve pneumatic actuators for smoke/fire dampers with pneumatic lines made out of hard drawn copper tubing that meets copper tubing specifications under Environmental Control Systems.
3. Electric actuators to have an end-switch or clutch to reduce force on the damper when it is being held open. Do not use stall-motors on electric actuators.

Access Doors

1. Access doors to be hinged, latched, and gasketed. Where located in insulated ductwork, provide an access door that is double walled and insulated to same level as duct in which they are located.
2. Access panels need to open and close easily without damage to duct insulation, and reseal tightly on re-closure.

Installation, Fabrication and Construction

General

1. Expose no raw fiberglass fibers to the air distribution system air stream or to occupied space.
2. During storage, transport, and installation prior to start-up, cover the ductwork and air terminal boxes with plywood and/or plastic as necessary to keep them dry, clean, and protected from damage.
    a. Replace metal that is dented or has a damaged finish.
    b. Replace duct liner that is torn or wet.

Ductwork

1. Specify to cover the ends of ductwork while they are in storage and after installation prior to start-up, so they are protected from accumulation of dirt.
2. Thoroughly clean ductwork and plenums of debris and small particles of rubbish and dust before installing and making final duct connections.

3. Locate plenums at least 4 inches AFF to protect them from water in case of mechanical room flooding. Provide adequate support.
4. Provide each plenum area with a light. Include an "ON" pilot light on switch.

Fume Hood Ductwork

1. Slope all horizontal ductwork down towards the fume hood. Low points or "bellies" in the ductwork run are unacceptable.
2. Some retrofits may require to tie-into existing glazed ceramic ducts and vitrified clay tile ducts. Provide appropriate transition detail.
3. Decontaminate fume hood ducts being removed as part of the project.
4. Provide a flanged removable spool piece (minimum of 12 inches long) at each fume hood connection. Use spool sections for leak tests, inspection, and to facilitate removal of equipment. Install suitable gaskets at flanged joint connections.
5. Provide adequate space and easy access to facilitate inspection, repair, or replacement of exhaust ducts.
6. The target design velocity in each duct is in the range of 1200 to 1500 feet per minute (fpm) to prevent condensed fumes or particulates from adhering to the walls of the ducts, settling out onto horizontal surfaces, and to address acoustical issues. The actuated exhaust terminal unit needs to consider noise and prevention of product deposition in the ducts.

Fume Hood Exhaust Stacks

1. See Environmental Health & Safety Laboratory Safety Design Guide for air flow study requirement.
2. Terminate fume hood exhaust stacks at whichever is the greatest of the following: At least ten feet above the roof for workers safety or stack height as determined by the air flow study.
3. Design discharge stack velocity to be at least 3000 fpm.
4. Do not provide exhaust stacks with weather caps or louvers, which require the air to change direction or cause turbulence upon discharge. Provide means to drain rainwater from exhaust stacks.

Zone Fan-Powered Air Terminal Boxes

1. Cover air inlet and discharge openings for air terminal boxes while they are in storage and after installation, prior to start-up to prevent accumulation of dirt.
2. Coordinate location of filters for easy access and replacement.
3. Orient secondary air inlets either down or sideways, not toward the ceiling.
4. Provide enough clearance between the secondary air inlet and the nearest surfaces to avoid restriction of air flow.

Access Doors

1. Provide hinged access doors on rectangular ductwork, air handlers and plenums. On round and oval ductwork provide removable access panels.

2. Provide access doors for all plenum areas. Provide latches operable from both inside and outside the plenum.
3. Provide access doors that open against pressure, and are self-closing due to the direction of airflow and by pressure differential. No exceptions.
4. Provide access panels upstream of all fire dampers, smoke/fire dampers, and coils, and elsewhere where occasional access is required. Provide access panels to both sides of turning vanes.

Duct Pressure Tests

1. Pressure test all ductwork in shafts, all plenums, fume exhaust ductwork, snorkel exhaust ductwork and all ductwork with a pressure rating of more than 2 inches (negative or positive). For ductwork with a pressure rating of 2 inches or less (negative or positive), test two Owner selected supply ducts on each floor, and one Owner selected exhaust or return duct
2. Demonstrate to an Owner representative that the ductwork passes the following pressure tests before it is insulated or covered by walls or ceilings. Test ductwork after all associated smoke/fire dampers, fire dampers, pressure relief doors, and access doors have been installed.
3. Discuss test pressures applied to each system with Engineering Services.
4. Before testing, provide the Owner- with the table or curve of pressure drop versus flow for the orifice being used to measure leakage. Provide data that is certified and an orifice that is clearly labeled so that a correlation between the orifice and table can be established.
5. Maintain a set of drawings for recording and sign-off of each tested section.
6. After each day of testing, submit to the Owner a copy of the paperwork recording the raw test data, calculating the duct areas, designating the duct category, and comparing the allowable and actual results.
7. Maintain pressure testing records on site. Provide a copy of current pressure test results if requested by an Owner Representative.

General Environmental Supply, Return, Exhaust, and Outside Air Ductwork Test Procedure

1. Close off and seal openings in the duct section to be tested. Connect the test apparatus to the duct by means of a section of flexible duct.
2. Test for leaks as follows:
   a. Start blower with its control damper closed.
   b. Gradually open the control damper until the duct pressure reaches 2 inches W.G. in excess of designed duct-operating pressure.
   c. Survey joints and seams for leaks. Mark each leak and repair after shutting down blower. Do not apply a retest until sealants have set.
   d. After leaks have been sealed, retest failed sections of ductwork until satisfactory results are obtained. Contact the Construction Coordinator to schedule an Owner’s Representative to witness re-tests.

Fume Exhaust Ductwork Test Procedure

1. Connect a blower to the duct specimen through a shutoff valve. Provide a magnehelic gage or inclined manometer with 0 inches to 10 inches W.G. range on the duct side of the shutoff valve.
2. Provide temporary seals at all open ends of the ductwork.
3. Average test pressure shall be 6 inches w.g. Initial pressure shall be 7 inches w.g.
4. Test all fume duct joints from the fume hood collar to the fan inlet flex connection, not inclusive.
5. To prevent over-pressurizing the ducts, start the blower with the variable inlet damper closed. Controlling pressure carefully, pressurize the duct section to the required level. When the pressure of the duct reaches 7 inches W.G., close the shutoff valve.
6. Using a stopwatch, measure the time elapsed from when the duct is at 7 inches w.g. to 5 inches w.g. Use the formula t = 6.23D to determine if the duct passes the test. ("D" is the nominal duct diameter, measured in inches; "t" is the MINIMUM allowable elapsed time, measured in seconds.)

Pressure Relief Doors or Panels

1. Demonstrate to an Owner's representative that the relief devices are functioning per the design intent and the ductwork is not damaged during a fire alarm test.

Smoke/Fire Damper Tests

1. As part of the test, the Contractor needs to demonstrate to an Owner's representative the full functionality of each smoke/fire damper by visual observation of the blades as it strokes "full open" and "full closed." All of the smoke/fire dampers need to pass the Owner-witnessed test before tests are witnessed by the Fire Department. To allow observation of the damper blades, Contractor to open access doors before the test begins.

Fire Damper Tests

1. The Contractor to demonstrate to an Owner's witness that the fire dampers drop from the "full open" to the "full closed" position by gravity when the fusible link is removed. Perform tests for the Fire Department only after fire dampers have passed the Owner-witnessed test before tests are witnessed by the Fire Department. Open access doors to allow observation of the damper blades by the Contractor before the test begins.

H. Hydronic Heating

Programming

1. Establish laboratory and research space temperatures as part of the technical programming process. Design unoccupied spaces, including mechanical and electrical rooms, to be heated to a minimum of 40° F for freeze protection.

Design Criteria

1. Programming for new hot water converters to include a reset schedule. Confirm existing reset schedule. Reset converter and radiation water temperatures by the outside air temperature. The normal reset schedule for a converter is to reset the water temperature from 180° F to 140° F as the outside air temperature changes from 20° F to 70° F respectively. The normal reset schedule for a radiation system is to reset the water temperature from 180° F to 100° F as the outside air temperature changes from 20° F to 70° F respectively.
2. Provide hot water heating radiation systems in areas where people are located adjacent to the outside wall. Examples of this type of occupancy are perimeter office areas and study carrels in libraries. Radiation systems are not required in lab areas, auditoria, or other areas where people are not seated along the exterior wall. Size radiation systems for 80% of transmission losses. Select finned pipe radiation to extend for the entire length of each glass area. If the perimeter heat loss does not exceed 250 BTUH/LF, radiation may be omitted.
3. Provide separate pumps and decoupled distribution systems for radiation systems and reheat coils. Discuss with Engineering Services if the systems are too small to justify separate systems. Stand-by pumps are required for critical systems. Please discuss standby requirements with Engineering Services and the Project Manager.
4. Reheat coil hot water is normally set at 140° F.
5. Night setback temperature control is required to protect the building and the equipment inside. Buildings with wood floors or equipment that would be affected by humidity (wood expands) are not allowed to drop below 55° F. Temperatures below 55° F have caused wood floors to buckle and pianos to go out of tune. For some buildings, a night setback temperature of 40° F, for freeze protection only, is acceptable. Discuss with Engineering Services and the Project Manager.
6. For up-feed system install control and isolation valves next to the apparatus on the same level.
7. Provide pipe test ports/wells to measure pressures and temperatures at each piece of equipment.
8. Provide a pot feeder, coupon rack and make-up water meter on each hydronic heating systems.

Products, Material and Equipment

1. For heating water piping, see Piping, Accessories and Pipe Pressure Testing section.
2. For systems that require freeze protection, provide propylene glycol.
3. Provide a 0.001 waterside fouling factor for the hot water converter selection.

4. At the high points in the water systems provide automatic air vents with a cast iron body, copper ball float and needle, or ball-type air valve. Provide manual air vents on zone heating coils. Provide automatic air vents on pre-heat heating coils. Provide low point drains on hydronic systems.
5. Surface mounted convectors must have sloping top to prevent materials from being placed/stored on top of the enclosure and blocking airflow. Avoid custom enclosures.

Installation, Fabrication and Construction

1. Provide sectionalized down-fed hot water piping systems with isolating and drain valves to simplify servicing without draining large volumes of water during maintenance and repair.
2. Allow space for tube removal on each hot water converter.
3. Provide relief valves on each hot water converter in compliance with the Boiler and Pressure Vessel code.
4. Do not install cast iron radiation, finned radiation, and air heating coils on the same pumped circuit.
5. Provide a hose end drain valve on each hot water coil.
6. Provide isolation valves at all air vents.
7. Locate expansion tanks at the highest point possible, and fit with gauge glass, drain, vent, and shut-off valve.
8. Provide control valves on convectors and radiation; dampers are not acceptable.
9. Provide isolation valves with rising stems at the inlet and outlet of each AHU or supply fan coil, or other major component. Locate valves so that each unit, and its control valve, can be serviced without draining an entire system or riser.

I. Ventilation Design Criteria

This section provides the design criteria for air handling units, ventilation fans and ductwork.

Design Criteria

1. When feasible, specify fan speeds less than 1,000 rpm to reduce noise levels and increase equipment life.
2. Fan installation in penthouses or mechanical rooms is preferred. Provide weatherproof protection for outdoor fans.
3. Locate the fan as the last element of the exhaust system to assure that the ductwork throughout the building is under negative pressure.
4. Install fans to be readily accessible for maintenance and inspection without entering the plenum. If exhaust fans are located inside a penthouse, consider the ventilation needs of maintenance workers.
5. Discuss laboratory ventilation interlocks and standby power requirements with EH&S and Engineering Services.
6. Coordinate the mechanical design with fume hood selection and location to achieve design performance criteria listed in the EH&S Laboratory Safety Design Guide.
7. Ventilate mechanical and electrical rooms for temperature control. The temperature setpoint to be a maximum of 90˚ F unless there are specific equipment temperature requirements. Provide outside air to all mechanical and electrical rooms as part of the ventilation system.
8. Provide provisions for future ventilation for ductwork and piping systems for storage rooms that may eventually become offices. Storage rooms are not considered unoccupied areas.
9. To maintain optimal indoor air quality, locate air intakes to avoid contamination from streets, exhaust vents, loading docks, and other sources of contamination. Locate outside air intakes a minimum of ten feet above grade. For air intake requirements see EH&S Laboratory Safety Design Guide.
10. To protect the air intake locate all building exhausts as remotely as possible from the intake. All fume exhaust systems must be located on the roof and discharge vertically.
11. Provide rain hood with bird screen for air intake. Avoid air intakes on southern elevations to minimize wind-driven rain and snow entrainment. Avoid using moisture eliminator in lieu of rain hood as it has high pressure loss and water collected on the louver is frequently drawn into the system before reaching the drainage gutter. For airflow simulation study requirements see EH&S Laboratory Safety Design Guide.
12. Most building systems require large units, in the 20,000 to 75,000 CFM range. The use of multiple small package units is discouraged.
13. Separate ventilation systems or zones may be required for separate occupancy uses, such as libraries and auditoria. The occupancy schedule of these areas are not always the same. Make provisions to run these areas when the remainder of the building is not in operation.
14. Do not use operable doors or windows as part of a pressurization or smoke control system where it may compromise building security.

15. Provide building copy/duplicating rooms and other rooms that contain several personal computer printers with exhaust systems to eliminate the migration of dust and chemicals. To maintain adequate indoor air quality, do not recirculate the air from these rooms.
16. Do not use fan rooms and mechanical rooms as supply or relief/exhaust air plenums. Duct all outside air and relief/exhaust air ducts to outdoors.
17. For fume exhaust, see Ductwork and Duct Accessories section and EH&S Laboratory Guide Manual.
18. Minimize return air plenums. Provide ducted return air system. Discuss with Engineering Services if plenum returns are proposed.
19. For separate snorkel exhaust system requirements see EH&S Laboratory Safety Design Guide.
20. Obtain current airflow and hydronic reports for remodel projects or system retrofits, as the actual operating conditions are likely different from the original design data.
21. Provide blow through design roof mounted supply air systems to eliminate negative pressure plenums exposed to the weather.
22. For naturally ventilated spaces specify the space temperatures to be maintained and provide supporting calculations.
23. Where designs incorporate fan arrays, provide a fan array airflow measurement system to measure individual fan airflow rates and total air handling unit airflow rate as well as fan alarming.
24. Select duct velocities to meet N.C. requirements of each occupied space. Identify NC level requirements in the Basis of Design narrative. Coordinate required NC levels with University Project Manager and users. Limit duct velocities to 1200 fpm for general supply and exhaust. Design fume hood exhaust duct velocities between 1200 and 1500 fpm.
25. See EH&S Laboratory Safety Design Guide for the following systems:

    a. laboratory ventilation interlocks and standby power
    b. air intake
    c. airflow simulation study
    d. fume exhaust
    e. snorkel exhaust

Plumbing

J. Compressed Air, Vacuum, Natural Gas & Nitrogen

Design Criteria

1. See Campus Mechanical Systems Section for connection to campus compressed air system.
2. Provide minimum 30 psig compressed air to laboratories. Provide separate service for systems with different pressure requirements.
3. The dew point of the utility compressed air service is in the range of 40ºF. Consider using an air dryer at service entrance to meet system dew point requirements.
4. If required, provide a separate valved branch to serve each of the environmental control air system and the fire protection system at the building service entrance.
5. Provide central building laboratory vacuum systems with an ASME receiver where practical. Duplex liquid ring pumps are the preferred type. Provide a liquid trap upstream of the receiver.
6. Vacuum pumps to be controlled by a pressure switch in the receiver set to operate between 22 and 25 inches of mercury vacuum.
7. Provide isolation valves at each floor and for each laboratory and equipment connection.
8. Size compressed air, vacuum and nitrogen pipes based on equipment specified demand or 0.5 scfm per outlet if none specified. Apply reasonable diversity factors based on user's input.

Installation, Fabrication and Construction

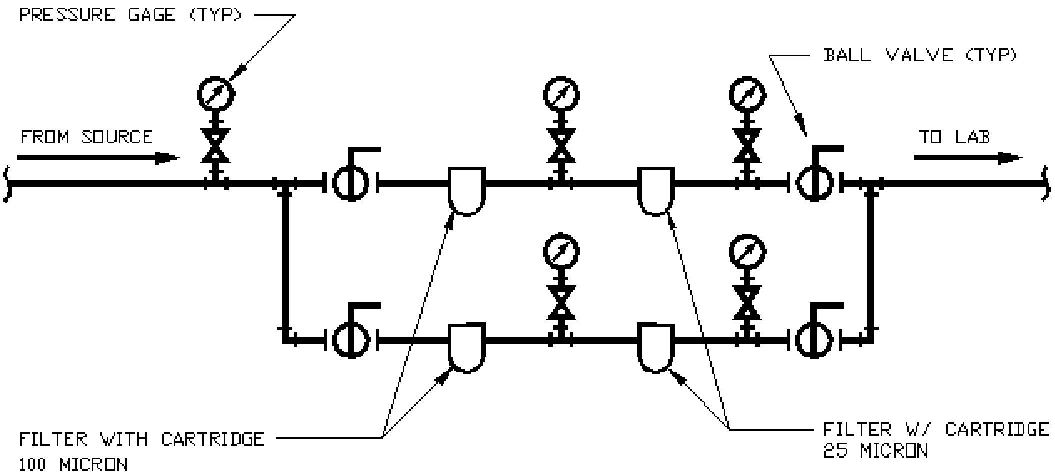
1. Pitch vacuum pipes in the direction of air flow.
2. Connect vacuum branch to the top of the main
3. Natural gas or natural gas vent piping must never be installed in the campus utility tunnel system.
4. Natural gas service entrance piping must be protected from accidental damage by vehicles, foundation settlement, or vibration. Where practical, the natural gas service entrance pipe to
5. Be above grade and provided with a self-tightening swing joint prior to entering the building.
6. Natural gas meters must be installed outside the building to avoid leakage concerns.
7. Immediately prior to turnover to the Owner, contractor must ensure that odor is present at natural gas lab outlets and odor fade has not occurred.

K. Potable and Nonpotable Water

Design Criteria

1. When incoming water pressure exceeds 80 psig, provide a pressure reducing station with two parallel PRVs (each sized at 2/3 of total flow, each valved to operate independently.)
   a. Design the system to provide a minimum pressure at the highest point of the building as needed for connected systems or at 25 psig, whichever is greater.
   b. The assembly to include appropriate valves, strainers, gauges, drains, etc. and include a bypass.
2. Provide the laboratory non-potable water system with parallel RP devices each sized 2/3 of the laboratory supply pipe capacity to prevent need for shutdown to test and repair. Protect the laboratory water system by installing faucets with built-in and un-removable vacuum breakers.
3. Locate irrigation system backflow preventers inside the building mechanical room.
4. Divide water system into smaller systems and provide isolation valve for each floor, each laboratory, each restroom and each plumbing fixture.
5. Design plumbing systems for sports stadiums, classrooms and auditoriums to handle load spikes.
6. Design piping with flow velocity not to exceed 4 feet per second.
7. Provide booster heaters for dishwashers and other equipment requiring hot water temperatures higher than building system design.
8. Do not install water piping below slabs on grade except for trap priming lines. Protect copper pipes from contact with concrete.
9. Provide electronic sensor faucets for all lavatories. Do not use electronic sensor flushometers for toilets and urinals.
10. For emergency safety shower and eyewash stations, refer to EH&S Laboratory Safety Guide.
11. Waterless urinals not allowed. Provide a full size domestic water by-pass around rainwater harvesting systems with adequate capacity to support all connected loads.
12. Provide a full-size domestic water valved by-pass around water pressure booster pumps.
13. Where a flood prevention valve is installed, provide a full-size valved bypass around flood prevention valve, or redundant flood prevention valves on building water supply.
14. Piston type flush valve for urinal and water closet using reclaimed water is not acceptable.
15. **See UW Standard Drawings:**

Water Filter Header

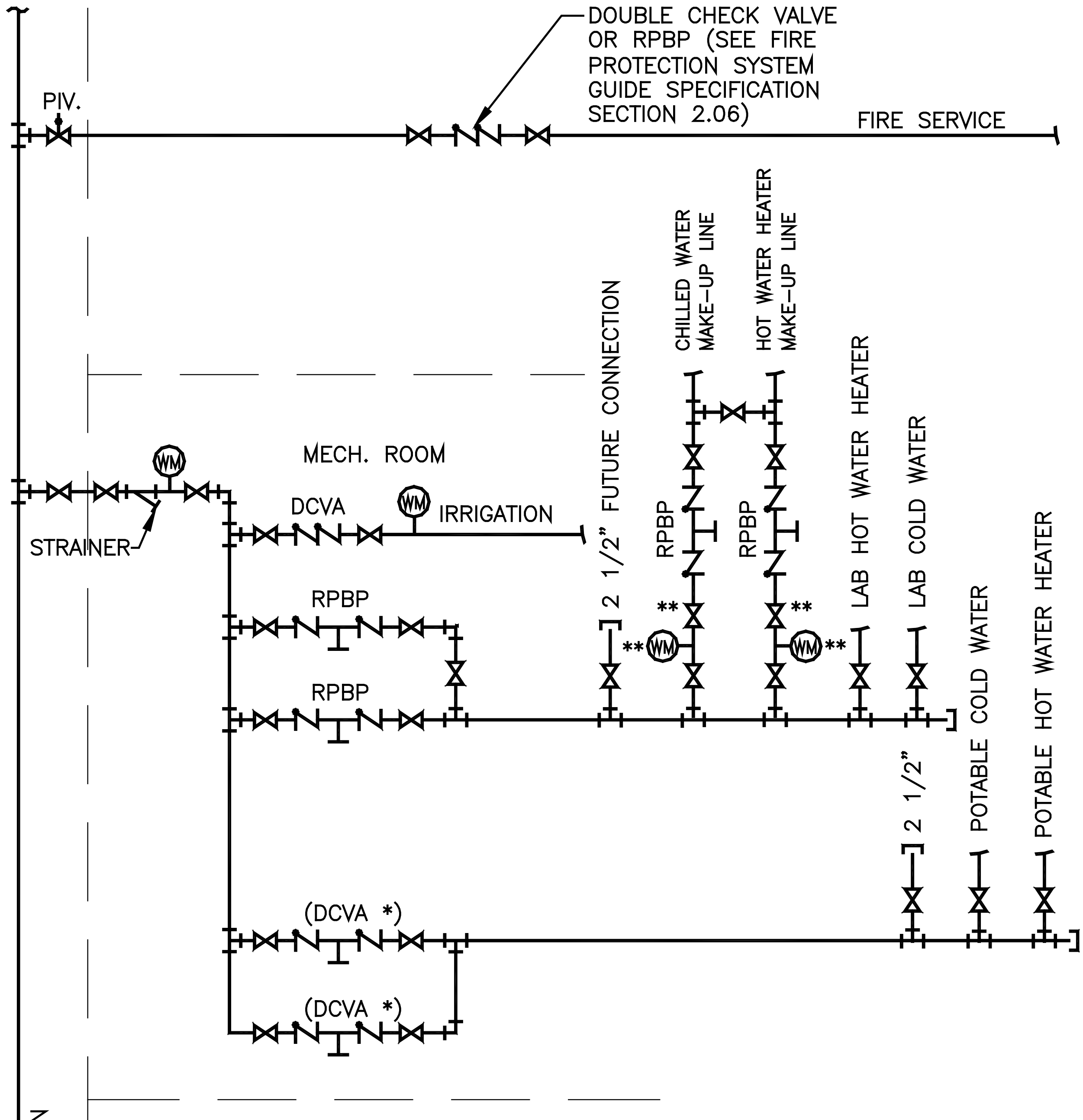


NOTES :

1. THE 100 MICRON FILTERS ARE USED TO EXTEND THE FILTER LIFE.
2. DUAL UNITS ARE PROVIDED TO ALLOW ONE TO BE CHANGED WITHOUT SHUTING DOWN THE SYSTEM.
3. FOR USE WITH DELICATE EQUIPMENT ONLY, NOT FOR THE BUILDING WATER SUPPLY.

FACILITY MANAGEMENT OFFICE PLANT ENGINEERING	STANDARDS DRAWING	DWN BY : T. Y. LO
	EQUIPMENT FILTRATION DETAIL	APPR BY :
		REV : C DATE : 12/13/13
DATE : 2/26/90		SD-M-23

Typical Building Water Header



LEGEND

*	RPBP REQUIRED ONLY ON BUILDING WITH HAZARDOUS PROCESSES.
DCVA	REQUIRED FOR ANY BUILDING OVER 30' HIGH
RPBP	REDUCED PRESSURE BACKFLOW PREVENTER
DCVA	DOUBLE CHECK VALVE ASSEMBLY.
**	REQUIRED ONLY FOR SYSTEMS WITH GLYCOL CONCENTRATION.

SD–M–19

L. RO/DI

Design Criteria

1. The minimum water purity standard for RO/DI systems is the College of American Pathologists (CAP) Type II. Provide Point-of-Use polishing equipment, if higher purity is required
2. Typical central equipment to consist of flushable prefilters, multi-media filters, reverse osmosis unit(s), deionizers, carbon filters, ultraviolet lights, storage tank, and distribution loop pumps.
3. A water heater may be required upstream of the RO unit because they are most efficient when operated at an inlet water temperatures of 77ºF.
4. Design system to circulate RO/DI water continuously in a closed series loop layout from the central equipment to lab outlets throughout the building. The distribution loop piping must be sized to circulate the water at a velocity in the range of 4 to 6 feet per second under no demand conditions.
5. Provide RO/DI system storage tank capacity for 24 hours of estimated usage. Coordinate with the structural engineer for storage tank support.
6. Provide access for storage tank sanitization.
7. Install storage tank overflow pipe with a check valve or p-trap equipped with trap primer supplying suitable water quality.
8. Discuss point of use equipment.
9. Discuss water reclaim from RO/DI reject water.

Installation, Fabrication and Construction

1. Slope all horizontal piping to allow for free draining with a minimum slope of 1/8 inch per foot.
2. Minimize dead end pipe sections in the distribution system. Provide branch pipe drop to each outlet or piece of equipment. Dead ends to be no more than six pipe diameters.
3. Provide diaphragm valve for each pipe termination.

M. Waste and Drains

Design Criteria

1. Provide minimum 6-inches diameter side sewers.
2. Provide gravity waste drains. No waste pumping allowed without Engineering Services approval.
3. Investigate alternate side sewer designs to explore feasibility of eliminating backwater valve where required by code.
4. Connect all footing drains to the storm drainage system. If connection to the storm drainage system is not practical, the footing drain may be connected to the tunnel drainage system. Do not connect footing drains to an interior sump pump.
5. Connect drains from vaults with oil-filled transformers and shop areas where oil is present to an oil interceptor.
6. Connect garbage disposal waste piping to a major waste pipe with as few bends as possible. Provide accessible clean-outs in the waste pipe.
7. Locate centralized grease interceptors outside in an area accessible by service vehicle.
8. Provide a 6-inch diameter drain with 36-inch high standpipe for the discharge of fire sprinkler system test.
9. Do not connect flammable or hazardous chemical/liquid storage room floor drains to the sewer systems. Design an alternate drainage system in coordination with the Fire Code or contain in place if allowed.
10. Due to the unstable nature of the soils East of Montlake Boulevard NE, it is recommended that all piping below slab on grade be hung from the slab rather than supported by the soil. Coordinate with the structural engineer for piping support from slab.
11. Coordinate cleanout locations with Architectural layouts.
12. When required, provide backwater valve of same material as sewer pipe.

Installation, Fabrication and Construction

1. Do not install crosses into waste piping systems.
2. Connect to top of pipe and use a 1/8 bend located for branch connections to food service area waste piping.
3. Support waste and drainage piping crossing excavated areas on pre-cast concrete beams. Support concrete beams by the building structure and undisturbed earth.
4. Specify full size clean-outs for up to 4 inches. Use 4-inch clean-outs for all piping larger than 4 inches.
5. Floor drains: Slope floors to floor drains. Specify block-outs twice the size of the drain body and infill with non-shrink grout to prevent perimeter cracking at concrete.

N. Water Reclaim System

To meet the water conservation initiative of the University, all major projects are encouraged to install a water reclaim system.

Water Reclaim and Rainwater Harvesting

1. Consider potential sources for water reclaim:
    a. Rainwater (Do not harvest rainwater from green roof)
    b. Rejection from RO/DI water
    c. Cooling coil condensate recovery

Cistern

1. Do not harvest rainwater from green roof
2. Slope to low point
3. Overflow to storm system
4. Valving is required if the location is a permit required confined space

Piping and Pumping

1. Provide bypass around water reclaim system to ensure a continuous water supply

Filtration and Water Treatment

1. Use UV for water sanitization in lieu of chemical treatment if feasible
2. Calcite filter for pH

Reclaimed Water Usage

1. Ensure water quality is suitable for any specific use
2. Consider use of reclaimed water for the following:
    a. Toilets/Urinals
    b. Irrigation
    c. Cooling Tower

Specific Mechanical Systems

O. Commissioning

Background

1. New facilities have become much more complex, requiring that new methods of start-up and operation be employed to assure that each facility functions as intended.
2. There are many critical participants involved with a comprehensive building commissioning program. The participants are the Commissioning Agent, Contractors, Consultants, and the Owner. The Commissioning Agent is engaged directly by the Owner, and the Test Engineer is a member of the prime Contractor's team. The commissioning agent and the test engineer have clearly defined responsibilities, and both become the essence of the final quality assurance program.

Design Criteria

1. Consultant to provide Owner's Project Requirements (OPR) document with input from Owner.
2. Depending on a project size and scope, the UW will typically hire a Commissioning Agent directly. This is a firm skilled in commissioning facilities of the type represented by the specific project and is referred to as the Commissioning Agent or Authority. The Commissioning Agent is hired prior to construction to be available to work with the Design Team and Contractor. In some cases the Commissioning Agent may be hired during design to contribute expert advice before the project is bid. Commissioning of the project's life safety systems need to be coordinated with and approved by UW Environmental Health and Safety.
3. The specific duties of the Commissioning Agent are:
   a. Review the Contractor's systems start-up plans.
   b. Review the Contractor's equipment and component test procedures.
   c. Review the Contractor's systems and inter-systems functional performance test procedures.
   d. Witness, verify and approve satisfactory completion of equipment and component tests and systems and inter-systems functional performance tests.
   e. Review and approve specified documentation.
   f. Coordinate the TAB firm's participation in the project.
   g. When commissioning has been successfully completed, recommend final acceptance to the Owner.
   h. Provide a project commissioning plan and functional performance test (FPT) procedures to be reviewed and approved by the project team.
   i. Generate and maintain an issue log throughout the commissioning process
   j. Provide the final commissioning report in a timely manner
4. Generally, the contract documents require the prime Contractor to engage a Test Engineer to organize, schedule, and conduct all equipment and apparatus tests and prepare and perform all system functional performance tests. This organizing, scheduling and testing is presented to the Commissioning Agent and UW Environmental Health and Safety for fire/life safety projects for review and approval.

5. The primary roles of the Test Engineer are to develop appropriate test procedures for all equipment/systems being tested, complying with the manufacturer's standards and procedures, and to ensure that all is successfully completed within the contract completion period.
6. The specific duties of the Test Engineer are as follows:
    a. Develop schedules for all testing; integrate testing into the master construction activity schedule; and coordinate all subcontractor testing.
    b. Perform system tests during both the winter and summer modes. Temperature tests can only be made on a design day. The Commissioning Agent is responsible to return to the site on a design day to complete these tests.
    c. Coordinate directly with each subcontractor on the project specific to their responsibilities and contractual obligations.
    d. Observe the start-up and initial testing of equipment by the Contractor and subcontractors, and then all final tests of equipment and systems.
    e. Manage all cross system testing such as HVAC, building automation, fire alarm, emergency power, life safety, elevators, etc.
    f. Review operation and maintenance information and as-built drawings provided by the various subcontractors and vendors for verification, organization, and distribution.
7. The Commissioning Agent may be hired prior to construction to be available to work with the Design Team and Contractor (Please consult with Engineering Services at early design phases). The Commissioning Agent can contribute expert advice before the project is bid.
8. For projects with a MACC less than $3 million, it may not be necessary to require the prime Contractor to engage a Test Engineer. The scope of commissioning and the extent of commissioning requirements may be reduced as may be appropriate to the complexity and sophistication of the specific project. These decisions must be made by the Consultant and the University, via specific discussion of the commissioning program, and all related decisions and commitments made prior to the end of the design development phase.
9. Even though a Test Engineer may not be required on all projects, commissioning requirements for the project are still incorporated into the contract documents. The prime Contractor is required to designate, in writing, a member of the construction team to be responsible for the commissioning program.
10. For all projects, a critical requirement for the prime and subcontractors is development of the comprehensive test procedures for equipment and systems. This test is based on the operating criteria, test parameters, and acceptable results required. Many contractors have not had experience in this area. Therefore, someone who specializes (or has had experience) in development of test procedures is required.
11. The University has developed a library of test procedures for the range of equipment and systems it has commissioned. To a degree, there is a somewhat generic quality regarding test procedures for common equipment and systems. However, in every instance, such procedures must be carefully reviewed and adapted to the unique characteristics and design conditions of the project.
12. The University makes this material available to consultants and contractors for reference during design and construction. Doing so helps to reduce the time required for such development,

develop more consistent testing/commissioning, and gradually improve the quality of the program.

Construction Submittals

1. Preliminary submittal
    a. Commissioning plan
    b. Basis of Design documentation
    c. Sample installation audit forms
    d. Draft startup plan
    e. Draft commissioning schedule
    f. Draft functional performance test procedures
2. Final submittal
    a. Commissioning plan
    b. Basis of Design documentation
    c. Installation audit forms
    d. Startup plan and startup forms
    e. Functional performance tests
    f. Commissioning progress reports
    g. Commissioning issues matrix
    h. Commissioning meeting minutes
    i. O&M preliminary review
    j. Owner Training Plan
    k. Final Commissioning Report

P. Environmental Control Systems

Environmental Control Systems Overview

Provide a standalone building management system for operating the mechanical system and interfacing with the campus FACNET

Approved Manufacturers (no substitutions):

1. Siemens Industry Building Technologies Issaquah Branch
2. Johnson Controls Bothell Branch
3. Alerton by ATS Automation

Hardware and Software

1. Operator Stations - Local Operator Station (LOS) Provide a PC station in a designated operations room with all required hardware and software. All components to be the latest version, capacity and speed available in the current high-end consumer market.
   a. Microsoft windows base operating system
   b. A complete software package with optimal architecture with pulldown menu and "one-click" approach
   c. A video and audio card capable for dual monitor displays
   d. Ports for connections with all peripheral components and network interface. Provide a minimum of two spare for each type of ports
   e. Power surge protection
2. Laptop - Portable Operator Station (POS): Provide on laptop with the same general functions and features as the LOS
3. Controllers - Each controller to be stand-alone control upon communications failure. The controller to retain its programming during a power failure and resume operation without program reloading from another device.

Graphic Display

1. Submit all graphic screens for approval prior to implementation. Display all controlled and monitored equipment within the graphics screens.
2. Display systems on a single graphic.
3. Provide floor plans with the approximate location of equipment, sensors and monitored points.
4. Provide a summary page including setpoints, real time values, and valve and damper positions for each air handling unit system.
5. Provide sub-graphic for each major system including sequence of operation and setpoint values.
6. Provide dynamic graphics for fans, pumps, compressors, dampers that show a different color when operating (green). Indicate when a component is alarm with flashing red.

Interface

1. FacNet - The contractor shall provide all hardware, software, and licensing to provide secure communication, over the campus FACNET using TCP/IP, from the LOS or POS within the facility to the vendor's campus server for their system
2. Secured DDC Room – Provide a dedicated, ventilated, well-lit and secure control room to house the environmental control system's main terminal, operating manuals, and mechanical drawings.
3. Connection Port Enclosure – Install the campus Ethernet connection port inside a 12x12x6 inch lockable enclosure.

Interfacing the DDC with Equipment Built-In Controls

1. Indicate the relationship between the environmental control system and the dedicated (built-in) controls for specific HVAC equipment such as chillers, heat pumps, furnaces, and boilers.
2. Use built-in controls provided under other sections of the project specifications to handle staging and coordination of parts within each major piece of equipment. This provides a sole source of responsibility for the equipment's performance to avoid damage to the equipment, to increase safety, and to increase Contractor and manufacturer responsiveness during problem solving
3. The building's environmental control system may offer monitoring and enable the local controls for "on/off." Review with Engineering Services which parameters to be monitored by the environmental control system.
4. Operation of multiple supply terminal boxes in a single zone presents special problems. Discuss with Engineering Services.
5. Ensure adequate power and transformer sizing for devices starting and operating simultaneously (e.g. window actuators, damper actuators, blind operators, etc.)

Interfacing the DDC with Fire Alarm

1. Control system to return to normal operation unmanned in stages after a power outage or fire alarm.
2. The fire alarm system must control life safety mechanical equipment such as those serving shaft pressurization systems, refrigerant machinery rooms, or smoke control systems. At fans shut down by the fire alarm system, shut down authority to be effective for all positions of the local HOA or VFD controls. The environmental control system does not control fans after shutdown by the fire alarm system until after reset of the fire alarm system and reset of fire/smoke dampers. Toilet and other non-recirculating exhaust fans to remain on unless this creates a problem of excessive pressure on exit doors. Fume hood fans to remain operating. Consult with EH&S for further information.
3. Specify provision for a current switch for fire alarm system "run status."

Interfacing the DDC with Emergency Power

1. In buildings where mechanical systems operate under DDC control in emergency power conditions, the environmental control system to monitor the fire alarm panel to determine when the building is under a fire alarm condition. The Environmental Control System to monitor the

appropriate emergency power transfer switch to determine when there is loss of normal power and restoration of normal power.

2. Specify a restart schedule indicating equipment start-up priority.

Standby Power

1. Provide standby power for all FacNet Switches and control panels.
2. Provide a UPS (Un-interruptible Power Supply) having 5 year battery life and battery hot swappable capability for all cabinets containing controllers. Provide with fused duplex receptacle as the UPS power source. Monitor the UPS and provide an alarm point.

Renovation and remodel projects

1. Contact Engineering Services to decide what type of space and front-end equipment for the control shop will need to operate the system.
2. Pneumatic to DDC - The goal is to move from pneumatic to DDC controls. Consultant to evaluate this goal against limitations in project budget and schedule. Work with Engineering Services on a project-by-project basis to determine how these goals are to be balanced on a given project.

Sensors

1. Provide a tamperproof enclosure.
2. Hard-wire fan high-limit pressure switches and low-limit freeze stats
3. Provide a test port at each piping sensor.

Deliverables

1. Training - Specify provision for a minimum of 32 hours of classroom and on-site training in the operation and maintenance of the installed system. For the first training session, hold eight hours of this training prior to point to point testing.
2. SetPoint List - Provide a list of all the design setpoints and the final setpoints after commissioning is complete.

Q. Identification

Products, Material and Equipment

Control Wiring

1. Heat shrink labeling

Piping

1. Asbestos-free labeling: White lettering on a blue background label to read “asbestos free”. All other piping labels to have black lettering on a white background unless regulated; the color of the labeling is regulated by safety codes.
2. For loop piping systems, indicate on the labels whether they are supply or return pipes.
3. For cooling water pipes connected to the campus tunnel system, state “Central Cooling Water” on the labels. For chilled water pipes connected to a chiller within the building, state “Chilled Water” or “Process Chilled Water” on the labels.
4. Indicate pressures on labels for steam lines with pressure greater than 20 psig and on all gas lines (such as nitrogen, compressed air, etc.) over 30 psig.

Plumbing Fixtures

1. Labels for non-potable fixtures to have black ½-inch lettering and yellow background on either self-adhesive waterproof paper, plastic, or vinyl.
2. Labels for potable fixtures to have white ½-inch lettering and sky blue background on either self-adhesive waterproof paper, plastic, or vinyl.

Valves

1. On each valve tag, indicate the size and service.
2. Provide bronze valve tags that are 1” x 2½” with lettering 1/4” minimum height. Stamp or engrave tags lettering.

Equipment

1. Give the equipment name and I.D. on each equipment label. Use the identifiers given in the contract drawings.
2. Provide laminated black plastic equipment labels with lettering cut through to white background.

Installation, Fabrication and Construction

Piping

1. Throughout the project, indicate direction of flow and service at least once in each space, at least once every 20 feet, and at all wall penetrations for all piping.

2. Attach piping labels at each end with adhesive arrow bands around the full circumference of the pipe and overlapping at the ends.
3. Orient adhesive labels parallel to the pipe, and locate labels where they can be read from the floor or the most likely approach for access.
4. On all piping, apply labels stating "asbestos free" at least once in each space, at least once every 20 feet, and within 6 inches of each point of connection with existing piping insulation. Mark the circumference of the new insulation with a black marking pen at each point of connection with existing insulation and draw an arrow from the nearest "asbestos free" to the black line. On the arrow, write with the black marker "terminates here."

Plumbing Fixtures

1. Non-potable: Identify all fixtures dispensing non-potable water per Seattle Plumbing Code.

Valves

1. Tag each valve.

Equipment

1. Provide an equipment label for each major piece of equipment. Air terminal box identification to be readable from the floor.

R. Metering and Gauges

Meter Installation

1. Install and commission main meters and submeters as specified in UW Purchase Specifications. Ask UW Facilities for a copy of the current Purchase Specifications.
2. Provide all materials and cabling for a complete installation of each meter. Install meters per manufacturer's instructions. Test each metering system to meet data connection or transmission requirements.
3. Coordinate with UW Facilities to involve them in all meter discussions during planning, design and construction. UW Power Plant Meter Shop to provide steam condensate meter wiring connection diagrams for each project. Contractor to provide wiring diagrams for other meters for review and approval.
4. Coordinate the quantity and location of Facility Network (Facnet) Ethernet ports with Campus Utilities & Operations and UWIT. Contractor to provide a completed "Mechanical Meter Profile Report" form for each meter (see form below).

Gauge Installation

1. Provide thermometers and "pete's plugs" at all locations where fluid mixing or heat transfer occurs.
2. Provide pressure gages at all services entering the building, at pressure-reducing valve outlets, pump inlets and outlets, and on other equipment where required for confirming satisfactory operation.

Pipe and Fittings

1. Install thermometers where they can be read from the floor.
2. Mount pressure gages on ½-inch size pipe extensions with ½-inch shut off valves.

Pipe Accessories

1. Provide industrial quality thermometers with thermowell and 9-inch scale length. Provide a scale range of 30° to 240° F in hot water piping, or 0° to 100° F in central cooling water or chilled water piping.
2. Provide pressure gages with a 4-inch minimum size and a scale range approximately twice the operating pressure. Show units of measure on the face plate.

Duct Accessories

1. In fume exhaust ductwork, install two Pete's Plugs made of non-corrosive material in the exhaust duct at 90° to each other around the circumference for the purpose of pitot tube insertion.
2. Provide dedicated adjustable inclined manometer or magnahelic gauge on each air filter installed to indicate filter pressure drop.

Mechanical Meter Profile Report

Model:	
ID Number:	
Name:	
NVRAM:	

Firmware Versions

FirmWare	Boot	Runtime	Xilinx
Comm			
DSP			

Communication Settings

Item	Port 1	Optical	Port 4
Address			
Baud Rate			
Data Bits			
Parity			
Stop Bits 1			
Tx Delay			
Protocol			
Mode			

Time Setup

Time Zone:	
DST Enabled:	

DST Start:	
DST End:	
Line Sync:	
Frequency:	

Demand Setup **Block Window Sync**

Thermal Averaging Window:		Use Sync Pulse:	
Block Averaging Window:		High Speed Input #:	
Rolling Averaging Sub-Interval Window:		Generate End of Interval Pulse:	
Rolling Sub-Intervals:		Relay #:	
Predictive Rolling Window Average:		Pulse Width (ms):	

Trending Log 1 Interval

Hours	Minutes	Seconds

Trending Log 2 Interval

Hours	Minutes	Seconds

Network Settings

IP Address	
Subnet Mask	
Default Gateway	
Gateway Port Baud Rate	
Gateway Port Delay	
MAC Address (IEEE Registered)	

DNS Servers

DNS Server 1	
DNS Server 2	

Services

Modbus TCP Server	
Modbus TCP Client	
BACnet IP Server	
BACnet IP Client	
Web Server	
SMTP Server	
SMTP Client	
FTP Server	
FTP Client	
HTTP/Modbus RTU Server	

Alarm/Email

Email Server IP Address/Name	
Email Server Port	
Email Monitor Address	
Return/Reply Address	
Email Subject Text	
Email Server Requires Authentication	
Username	
Password	

FTP Client

FTP Server IP Address/Name	
FTP Server Port	
Startup Remote Directory	
Username	
Password	

Network Card Firmware Update Via Network

Enabled	
Server Port	
Server IP Address	
Client IP Address	
Subnet Mask	
Default Gateway	
Download Filename	

DNP LAN/WAN Settings

Mode:	

Connection:

DNP over TCP:		Listen on Port:			
DNP over UDP:		Listen on Port:			
Respond to:					

A	

S. Motors and VFDs

Electric Motors

1. Provide “off the shelf” motors that are readily available.
2. Provide NEMA rated 1800 RPM motors with Class F or H insulation when appropriately matched to the driven equipment. Do not select motor speeds requiring V-belt drive reduction ratios greater than 6 to 1.
3. Identify the type of control for every motor within the scope of the project.
4. Provide factory lubricated bearings for motors less than 1/3 HP. Sleeve bearings are only permitted for fractional HP motors and where specifically recommended by the equipment manufacturer as the better type of bearing for the application.
5. Provide vertical shaft motors with suitable thrust bearings.
6. Shaded pole-type motors ≥ 1/8 HP are not acceptable.
7. Provide open drip-proof construction motors. Where conditions dictate provide enclosed or explosion proof type motors. .
8. Size motors to operate between 70% and 95% of full motor load when running at full 60 Hz speed. If a larger future load is anticipated, size the motor mounting pad to accommodate the larger anticipated motor frame size.
9. Provide shaft grounding ring for motors that are controlled by VFDs. Ensure grounding path from vibration isolated equipment.

Variable Frequency Drives

1. By-Pass Starter or Dual VFD: A manual by-pass starter or dual VFD is typically required when there is no redundancy. Discuss the use of a By-pass starter or dual VFD with Engineering Services. Critical-need applications without redundancy require an automatic bypass feature or dual VFD feature. In some critical applications, a backup fan or pump and VFD is provided, in which case by-pass starters or dual VFDs may not be necessary. Provide the by-pass feature or dual VFD to be fully isolated. Operate all safeties in by-pass or dual VFD mode. Operate VFD or bypass starter by Manual Start Operation. Require a soft start for motor 50 hp and greater.
2. Amperage interrupt capacity: Requirements can vary depending on the electrical system design. The nominal requirement is a 65,000 RMS symmetrical ampere interrupting capacity. Some electric services require less capacity, coordinate the mechanical with the electrical designer and comply with the protective device study to determine the appropriate specification.
3. Radio frequency sensitive applications: A VFD may be installed in the vicinity of highly sensitive research or medical equipment. Radio microphones and sound reinforcement equipment may also be susceptible to RF generated by a VFD. An appropriate FCC rating may be necessary in these applications, and this requirement may result in the use of 6-step or 12-step technology VFDs. Review with Engineering Services if control and interface requirements in the guide specification cannot be met.
4. Interface with Environmental Control System: The guide specification requires both hardwire and digital connection to the environmental control system.

5. Interface with the Fire/Life safety Systems: Ensure the Fire/Life Safety system operation sequence is met in Manual, Off, Auto, and Bypass Modes. Verify the correct speed is maintained in all Modes.
6. Sheaves and impellers: Use Motor Speed as the adjustment mechanism for balancing critical paths in air and water systems. After testing and balancing is complete, adjust sheaves, impellers and motor sizes as necessary so that the motor operates above 55 Hz and between 70% and 95% of full load amperage when the maximum desired system pressures and flows are produced. When the motor operates in VFD bypass at 60 Hz, verify that system pressures and flows do not cause problems and the motor current does not exceed full load amperage. It may be necessary to install pressure protection switches and/or duct blowout panels to protect variable air volume systems from over-pressure. Coordinate these requirements with the Testing and Balancing requirements.
7. Line reactance: Provide a minimum of 3% input line reactance. This may be provided in the form of separate line reactors at the input of the VFD, reactors included as part of the DC bus or a combination of the two totaling 3% to 5%.
8. Total Harmonic Distortion (THD): Specify in the documents that the THD at the point of common coupling for all VFDs connected, is less than 5% and to provide required filtering equipment in conjunction with line reactors.
9. Output rate of rise, peak output voltage and wire length: Purchase and install VFDs that does not damage typical premium efficiency motors. Implementing the following three requirements essentially eliminates motor insulation and bearing failures associated with VFD use.
    a. Use output filtering to keep the rate of rise, for each pulse in the output, below 1,000 volts/microsecond.
    b. Use output circuitry, which prevents the peak output voltage from reaching 1,000 volts to ground at the motor.
    c. Limit wire length to less than 50 feet between the motor and VFD. Demonstrate the 50 foot distance in the contract documents.
10. Provide damper control accessory.
11. Provide display and keypad for all drives, mounted either locally through enclosure door or remotely.

Installation, Fabrication and Construction

Electric Motors

1. Do not expose motors to the weather. Install motors within the building or in suitable enclosures. If motors are not housed within the building structure, specify totally enclosed type motors, even though a weatherproof enclosure is provided. Provide motor heaters in outdoor enclosures.

Variable Frequency Drives

2. Mount the VFD as close to the motor as feasible with no more than 50 feet separation. Coordinate with the electrical designer to ensure that this requirement is met. It is also necessary that the VFD be solidly mounted to structural members.

a. Unistrut type structures can be used in most mounting circumstances.
b. Do not mount VFDs directly to the flexible sides of air handling units, plenums or ductwork.

Avoid mounting VFDs outdoors, inside plenums, or adjacent to piping that could spray a leak onto the VFD housing. Discuss VFD location with Engineering Services

T. Noise and Vibration Control

Design Criteria

1. Specify NC level requirement for each type of occupied space in the Basis of Design. NC levels to be approved by Engineering Services based on user's input.
2. Many campus buildings have vibration-sensitive equipment such as electron microscopes. Establish acceptable vibration criteria early in the technical program so that equipment, piping, and ductwork that require vibration isolation can be identified. Provide a table in the design documents which lists the vibration isolation requirements for piping, equipment and ductwork.
3. Analyze mechanical system equipment sound levels to control noise transmission. Select all mechanical equipment to meet the noise criteria (NC) requirement of each occupied space. Identify NC level requirements in Contract Documents.
   a. Minimize the use of fiberglass liner inside ventilation ducts. Do not install liner between the supply fan cooling coil and the terminal unit. Do not install liner on outside air intake ductwork. Minimize liner in the return air duct.
   b. Reduce fan and air noise by the use of sound attenuators, round or oval ducts, where feasible, instead of rectangular; Design fans at low RPM.
   c. High density duct liner with foil face can be considered downstream of the terminal unit to mitigate cross-talk noise between rooms.
   d. Insulate fan powered boxes with fiberglass and a hard, cleanable surface exposed to the air stream.
   e. In renovation projects, existing HVAC systems with fiberglass liner in good condition may be left in place.
4. At University of Washington Medical Center projects, ductwork sound lining is not acceptable.
5. Provide acoustic treatment in mechanical room walls and ceilings if adjacent areas are affected by noises generated in the mechanical room. Coordinate interior finishes with Architect.
6. Avoid "Floating Slabs" i.e., slabs that are acoustically isolated from the structural slab with insulation between the two slabs. These slabs are usually constructed before the building is "closed in" or protected from rain. Consequentially they are exposed to rain which saturates the insulation, making the acoustical performance ineffective and providing a breeding place for mold and mildew.

Products, Material and Equipment

Vibration Control

1. Provide spring-type or rubber-in-shear vibration isolators for rotating equipment on grade.
2. Provide spring-type vibration isolators and inertia bases for rotating equipment in areas not on grade.
3. Provide springs that are large diameter, stable type which do not require guides or snubbers.

Noise Control/Acoustic Treatment

1. If sound attenuators are used, pack-less types are strongly recommended.
2. Fan powered boxes that have lining exposed to the air stream to have a cleanable surface.

Installation, Fabrication and Construction

Vibration Control

1. Do not make rigid connections between rotating equipment and the building structure that short-circuit vibration isolation systems.
2. Verify mounting systems are not resonant with supported equipment forcing frequencies.
3. Level vibration-isolated equipment while equipment is under full operational load.
4. Install piping sections in reasonable alignment. Using vibration isolation components to correct misalignments is unacceptable.

U. Piping, Valve Pressure Testing and Accessories

Design Criteria

1. Design piping to allow for ample movement and flexibility for expansion and contraction due to temperature changes.
2. Provide a service header for every service entering a building. Provide a shutoff valve in the service header piping immediately upon entry into the building. Install all meters, strainers, pressure reducing valves, backflow preventers, major branch connections, etc. at the service header. Provide bypass connections at the service header so that service to the building is continuous when maintenance is performed on the various components.
3. Provide valves to permit isolation of portions of the building piping systems for maintenance, alterations, and repair work without shutting down entire systems.
4. Provide individual shutoff valves to isolate all equipment from the piping system including pumps, coils, fixtures, fume hoods, bio-safety cabinets, and autoclaves.
5. The following table lists typical piping systems with its corresponding symbol, and pipe codes to reference subsequent Products, Materials and Equipment tables.
6. Example: Potable Cold Water; symbol CW, and pipe code P-1
   a. Pipe code table P-1 lists a maximum operating pressure of 100 lb/in2 and maximum operating temperature of 70º F.
   b. Facilities Services Design Standard – Mechanical - Plumbing Pressure Testing lists the recommended test pressure of 150lb/in2. Facilities Services Design Standard – Mechanical - Water Treatment and Flushing lists the recommended cleaning method of water flush.

Piping System	Symbol	Pipe Code	Pipe Test Method	Test Pressure, lb/in^2 gage
Acid Resistant Vent	ARV	P-3	Hydrostatic	(1)
Acid Resistant Waste	ARW	P-3	Hydrostatic	(1)
Carbon Dioxide	CO2	P-1	Pneumatic	1.5 x max. (2)
Central Cooling Water	CCW	P-4	Hydrostatic	250
Coil Condensate	CD	P-1	Hydrostatic	60
Compressed Air (Laboratory)	A	P-1	Pneumatic	150

Compressed Air (Pneumatic)	CA	P-1	Pneumatic	150
Condenser Water	CNDW	P-1	Hydrostatic	60
Fire Protection	F	P-10	(3)	(3)
Heating Hot Water	HHW	P-1	Hydrostatic	1.5 x max.
Helium Recovery	HR	P-1	Pneumatic	1.5 x max. (2)
Irrigation, Inside Building	I	P-1	Hydrostatic	150
Irrigation, Outside Building	I	P-9		
Laboratory Cold Water	LCW	P-1	Hydrostatic	150
Laboratory Hot Water	LHW	P-1	Hydrostatic	150
Laboratory Hot Water Circulation	LHWC	P-1	Hydrostatic	150
Laboratory Vacuum	LV	P-1	Pneumatic	100
Lake Water	LW	P-9	Hydrostatic	1.5 x max. (2)
Medical Gas	MG	P-8	Pneumatic (4)	(4)
Medical Vacuum	MV	P-8	Pneumatic (4)	(4)
Natural Gas	G	P-5	Pneumatic (4)	8
Nitrogen	N	P-1	Pneumatic	1.5 x max. (2)
Oxygen	O	P-8	Pneumatic (4)	(4)
Potable Cold Water	CW	P-1	Hydrostatic	150
Potable Hot Water	HW	P-1	Hydrostatic	150
Potable Hot Water Circulation	HWC	P-1	Hydrostatic	150
Process Chilled Water	CHW	P-1	Hydrostatic	1.5 x max.
Propane	P	P-5	Pneumatic	8

Refrigerant Liquid	RL	P-7	Pneumatic	350
Refrigerant Suction	RS	P-7	Pneumatic	125
Reverse Osmosis/De-ionized Water (High Purity)	DI	P-6	Hydrostatic	150
Roof Drain (Rain Leader)	RD	P-2	Hydrostatic	(1)
Sanitary Vent	V	P-2	Hydrostatic	(1)
Sanitary Sewer	SS	P-2	Hydrostatic	(1)
Sea Water	SW	P-9	Hydrostatic	1.5 x max. (2)
Steam (Low Pressure)	LPS	P-4	Hydrostatic	25
Steam (Medium Pressure)	MPS	P-4	Hydrostatic	90
Steam (High Pressure)	HPS	P-4	Hydrostatic	280
Steam Condensate	CNDS	P-4	Hydrostatic	1.5 x max.
Storm Drain	SD	P-2	Hydrostatic	(1)
Tempered Potable Water (Safety Shower/Eyewash)	TW	P-1	Hydrostatic	150
Trap Primer	TP	P-1	Hydrostatic	150
Well Water	WW	P-9	Hydrostatic	1.5 x max. (2)

Notes:

(1) In accordance with UPC – Min. 10 ft. head.
(2) 1.5 x Maximum Operating Pressure.
(3) Refer to NFPA and Environmental, Health & Safety - Fire Protection System section for information.
(4) Refer to NFPA for additional information.

Design Evaluation

Products, Material and Equipment

Pipe

1. Use industry standards for piping systems specified and comply with the following additional requirements:
2. The following tables list the typical service piping, standard operating pressures and temperatures, recommended testing pressures.

PIPE CODE P-1		
Service	Max Operating Pressure lb/in2 gage	Max Operating Temp Deg F
Carbon Dioxide (CO)	Varies	-
Coil Condensate (CD)	40	60
Compressed Air – Laboratory (A)	100	100
Compressed Air – Pneumatic (CA)	100	100
Condenser Water (CNDW)	40	85
Heating Hot Water (HHW)	Varies	190
Helium Recovery (HR)	Varies	-
Irrigation, Inside Building (I)	100	70
Laboratory Cold Water (LCW)	100	70
Laboratory Hot Water (LHW)	100	160
Laboratory Hot Water Circulation (LHWC)	100	160
Laboratory Vacuum (LV)	-29 in-Hg	100
Nitrogen (N)	Varies	-
Potable Cold Water (CW)	100	70

Potable Hot Water (HW)	100	160
Potable Hot Water Circulation (HWC)	100	160
Process Chilled Water (CHW)	Varies	60
Tempered Potable Water (TW)	100	80
Trap Primer (TP)	100	70
Sizes	½-inch and larger	
Pipe	Above grade: Copper Type L or stainless steel; Below grade: Copper Type K or ductile iron; CNDW, CHW & HHW above grade: 2½-inch and larger, black steel. Schedule 40 Compressed air piping in the tunnels: Schedule 40, black steel, welded, for larger than 2 inch pipe size and schedule 80, black steel, threaded for 2 inch and smaller pipe size. Irrigation outside: See remarks. Nitrogen piping: Clean all fittings/joints for medical gas service per NFPA 99; Mechanical joints are okay for copper and stainless steel water service piping.	
Wall Thickness	Standard Weight	
Valves	Single piece, full flow ball style. Valves to have a packing nut independent of the handle.	
Remarks	Irrigation: Refer to Civil – Irrigation section. LV: Connect branch piping section outlet to top of main. Nitrogen piping system to be brazed under a nitrogen purge. Copper press fitting pipe joining systems okay on CW, LCW, HW, and LHW piping Other mechanical joints okay only for 2-1/2" and larger CW, LCW, CHW, HHW, CNDW and F piping	

PIPE CODE P-2		
Service	Max Operating Pressure lb/in2 gage	Max Operating Temp Deg F
Roof Drain (RD)	N/A	N/A
Sanitary Vent (V)	N/A	N/A
Sanitary Sewer (SS)	N/A	N/A
Storm Drain (SD)	N/A	N/A
Sizes	All	
Pipe	Above grade: Cast Iron CISPI 301, no hub; Below grade: Cast Iron CISPI 301, no hub with extra heavy coupling or hub & spigot. Roof drains: Cast iron.	
Wall Thickness	Standard Weight	
Remarks	Above grade force main & force main-vent same as pipe code P-4. Minimum test pressure: 125 lb/in2. Below grade: Refer to Civil sections for utilities.	

PIPE CODE P-3		
Service	Max Operating Pressure lb/in2 gage	Max Operating Temp Deg F
Acid Resistant Vent (ARV)	N/A	N/A
Acid Resistant Waste (ARW)	N/A	N/A
Sizes	All	

Pipe	Above grade: Polypropylene; pigmented, flame retardant Below grade: Polypropylene; pigmented, non-flame retardant
Wall Thickness	Schedule 40
Remarks	Above grade: Fusion joints. Below grade: Fusion joints. Within laboratory casework (accessible): Mechanical joints allowed at the connection to the plumbing fixture.

PIPE CODE P-4		
Service	Max Operating Pressure lb/in2 gage	Max Operating Temp Deg F
Central Cooling Water (CCW)	200	70
Steam (LPS)	15	259
Steam (MPS)	60	338
Steam (HPS)	185	388
Steam Condensate (CNDS)	Varies	-
Sizes	All	
Pipe	Black steel	
Wall Thickness	LPS and CCW, larger than 12 inch Standard Weight; LPS, MPS, HPS and CCW, 2-1/2 inch to 12 inch Schedule 40; LPS, MPS, HPS and CCW 2 inch and smaller Schedule 80; CNDS, Schedule 80.	
Valves	Campus utility building isolation valves 2 1/2 - inch and larger for CCW, HPS, MPS and LPS	

	service to be triple offset or quadruple offset high performance butterfly valves, see remarks. At CCW control valves, provide DeltaPValve by Flow Control Industries, no substitutions. Inside the building CCW 2-1/2 inch and larger to be Class 150 or Class 300 butterfly valves. CCW 2 inch and smaller to be Class 150 or Class 300 ball valves or rising stem gate valves. HPS, MPS, LPS and CNDS to be Class 150 or Class 300 rising stem gate valves.
Remarks	2-inch and smaller: Threaded forged fittings; 2½-inch and larger: Butt weld type forged fittings; All steam raised faced flanges, with spiral wound gasket. High performance butterfly valves to be Class 150 or Class 300, triple offset or quadruple offset, steel, lugged style, and gear operated by TYCO, Vanessa; WEIR, Tricentric; or QUADAX VALVES, Inc., no substitutions. Specify 300# or higher rated fittings where Schedule 80 piping is used.

PIPE CODE P-5		
Service	Max Operating Pressure lb/in2 gage	Max Operating Temp Deg F
Natural Gas (G)	5	-
Propane (P)	5	-
Sizes	All	
Pipe	Black steel	
Wall Thickness	Schedule 40	

Remarks	Above grade: 2-inch and larger butt-welded fittings; 2-inch and smaller threaded fittings allowed. Below grade: Refer to Civil sections for utilities. See EH&S Laboratory Safety Design Guide regarding lab emergency gas shut-off valves.

PIPE CODE P-6		
Service	Max Operating Pressure lb/in2 gage	Max Operating Temp Deg F
Reverse Osmosis/De-ionized Water (DI)	100	70
Sizes	All	
Pipe	Polypropylene – non-pigmented	
Wall Thickness	Schedule 40	
Valves	Union body, full port, ball style	
Remarks	Electrofusion joints for distribution piping. IR butt weld joints allowed at generation skids. Piping to be continuously supported.	

PIPE CODE P-7		
Service	Max Operating Pressure lb/in2 gage	Max Operating Temp Deg F
Refrigerant Suction (RS) Refrigerant Liquid (RL)	High Side: 250 Low Side: 90	150 70

Sizes	½-inch and larger
Pipe	Copper, ACR type
Wall Thickness	Standard Weight
Remarks	No flared connections and fittings. Braze piping under nitrogen purge.

PIPE CODE P-8		
Service	Max Operating Pressure lb/in2 gage	Max Operating Temp Deg F
Medical Gas (MG) Medical Vacuum (MV) Oxygen (O)	Varies Varies Varies	150 70 -
Sizes	½ inch and larger	
Pipe	Medical Gas and Oxygen: Copper, wall thickness per Code, Medical Vacuum: Copper Type L, Piping to be specially prepared and labeled for medical service, oxygen and vacuum.	
Wall Thickness	Standard Weight	
Remarks		

PIPE CODE P-9		
Service	Max Operating Pressure lb/in2 gage	Max Operating Temp Deg F

Irrigation, Outside Building (I) Lake Water (LW) Sea Water (SW) Well Water (WW)	100 Varies Varies Varies	70 70 70 70
Sizes	½-inch and larger	
Pipe	Polypropylene or CPVC or PVC if not exposed. Sea water, outside: HDPE	
Wall Thickness	Schedule 40	

PIPE CODE P-10		
Service	Max Operating Pressure lb/in2 gage	Max Operating Temp Deg F
Fire Protection (F)	-	-
Sizes	See remarks.	
Pipe	See remarks.	
Wall Thickness	See remarks.	
Remarks	Refer to NFPA and Environmental Health & Safety Design Guide – Sprinkler Protection & Standpipes section.	

Pipe Insulation

1. Provide metal jackets for all new piping insulation located in outside air intakes, building plenums, and on all piping insulation less than 8 feet above the finished floor in mechanical rooms.

Valves

1. Provide valves with flanged, grooved or threaded ends. Valves may have solder ends for 2-inch and smaller copper piping. See Mechanical - Piping section.
2. Provide gate valves with rising stem and union bonnet for 2-inch and smaller.

3. Provide ball valves for 2-inch and smaller pipe and butterfly valves for 2½-inch and larger pipe.
4. Balancing valves to be globe type with ports and graduated scale. Do not use balancing valve as an isolation valve. All balancing valves to be sized based on the appropriate flow within the range of the valve not the service pipe size.
5. Plug valves larger than 2-inch size to be lubricated type.
6. Provide check valves on each individual closed loop makeup water system.

Strainers

1. Provide wye type strainers in 2-inch and smaller piping.
2. Provide basket type strainers in piping larger than 2-inch, except for steam piping.
3. Provide wye type strainers in steam piping.
4. Match strainer body material with piping material.
5. Provide strainer screens with a free area not less than three times the free area of the pipe line. Perforations to be 1/16-inch size. Provide stainless steel screens in steam strainers. Provide brass screens in all other strainers.

Installation, Fabrication and Construction

Pipe and Fittings

1. Provide unions or flanged connections at equipment for maintenance and repair.
2. Provide insulating nipples or flanges between to connect piping with dissimilar metals.
3. Provide welding outlets where branch piping is smaller than the main. Provide welding tees for all other cases.

Pipe Sleeves

1. Provide sleeves large enough to allow insulated piping pass through without disrupting the insulation.
2. Provide elastomer wall penetration modular seals on all sleeves through exterior walls below grade.
3. Provide UL Listed fire-stopping material on all sleeves through fire rated floors and walls.

Valves

1. Install valves with the stem vertical. When this is not possible, they may be installed rotated but never less than horizontal under any circumstance.
2. Provide isolation valves at each floor for all services.
3. Install isolation valves staggered where they come out from a pipe shaft so they are completely and conveniently accessible.
4. Install valves with adequate room to permit removal of the bonnet, disk, and trim without removing the valve from the line.
5. Provide globe valves where throttling is required, except for balancing valves.

6. Provide balancing valves at all pumps, main pipe branches, and all system coils. Balancing valves at VFD-driven pumps may be omitted if means for measuring flow are provided (e.g. Venturi taps with flow measuring kit).
7. Triple Duty valves are not allowed.
8. Discuss the sizing of balancing valves for small coils (less than 1 gpm) with Engineering Services.

Strainers

1. Provide a ball valve and hose-end adapter for blow-down on all wye strainers, except use gate valve on steam and condensate strainers.
2. Provide strainers ahead of automatic control valves, steam traps, and in main service piping to buildings. Those steam traps provided for a device having an automatic control valve do not require strainers.

Headers

1. Space components apart by at least two pipe diameters between flanges.
2. Locate header assemblies approximately 4 feet above the floor.

Piping Pressure Tests

1. Pressure test all pipe systems.
2. Test piping after all associated fittings, and valves have been installed.
3. Demonstrate to an Owner representative for each pressure testing. Leave the pipe exposed and do not insulate until the associated pipe section has been signed off by an Owner representative.
4. Repair leaks discovered during pressure testing. Retest failed sections of piping until satisfactory results are obtained.
5. Maintain a set of drawings for recording and sign-off of each tested section.
6. After each day of testing, submit to the Owner a copy of the paperwork recording the raw test data, designating the piping system and Pipe Code, and comparing the allowable and actual results.

Pipe Testing Methods

1. Hydrostatic pressure testing: Use clean, fresh city water for test. On compressed gas piping remove water from piping systems after testing and dry by blowing dry, oil-free air or nitrogen through lines.
2. Pneumatic pressure testing: Perform testing with dry, oil-free air or nitrogen on piping systems.
3. The following table lists typical piping systems and the corresponding recommended test method and test pressure.

Piping System	Pipe Code	Test Method	Test Pressure, lb/in2 gage
Central Cooling Water	P-4	Hydrostatic	250
Condenser Water	P-1	Hydrostatic	60
Heating Hot Water	P-1	Hydrostatic	1.5 x max.
Process Chilled Water	P-1	Hydrostatic	1.5 x max.
Refrigerant Liquid	P-7	Pneumatic	350
Refrigerant Suction	P-7	Pneumatic	125
Steam (Low Pressure)	P-4	Hydrostatic	25
Steam (Medium Pressure)	P-4	Hydrostatic	90
Steam (High Pressure)	P-4	Hydrostatic	280
Steam Condensate	P-4	Hydrostatic	1.5 x max.

V. Pumps

Basis of Design

This section applies to the selection and installation of pumps for hot and chilled water circulation, condenser water systems, sump and steam condensate return systems.

Design Criteria

1. Locate pumps in mechanical rooms whenever possible and provide easy service accessibility and isolate them to prevent pumping or vibration source noise from disturbing the surrounding occupied areas.
2. Provide pumps that allow installation of a larger impeller to meet future requirements whenever possible.
3. Provide stand-by pumps when shutdowns cannot be tolerated for repairs and maintenance. For example, condensate pump stations, sewer lift stations, and primary pumping loops.
4. Provide pumps that operate at 1800 rpm.
5. Provide centrifugal-type pumps where the shutoff head is not more than 25% greater than the operating head.
6. Provide check valves in the pump discharge piping when pumps are operating in parallel, standby, or whenever a reverse flow may occur.
7. Provide “lead-lag” start controls for dual pumps. Provide the ability to manually alternate the pumps on a “lead” start.
8. Obtain discharge head information for condensate pumps from the UW Project Manager. There are locations on campus at an elevation lower than the Power Plant. Other locations are gravity return to the Power Plant hot well.
9. Provide duplex pumps with standby power for steam condensate pumps stations and sewer lift stations.
10. Ensure that a copy of each pump curve with design conditions plotted is included in the Operations and Maintenance manual.

Products, Material and Equipment

1. Provide a pump that is a complete, integrated unit consisting of pump, motor, shaft, coupling, frame and base as manufactured at the factory.
2. Pumps: Centrifugal, end suction or horizontal split case type.
3. Provide close-coupled pumps up to 1 hp; otherwise provide a frame-mounted type.
4. In-line circulators may be used when they can be adequately supported and are easily accessible.
5. Provide frame-mounted, not close coupled, chilled water pumps, so that the entire casing and connections may be completely insulated.
6. Provide mechanical seals on all pumps, suitable for the intended service.
7. Provide certification from the pump manufacturer that the mechanical seals for pumps are suitable for the maximum expected temperature and chemical treatment used.

8. Provide pressure gauges upstream and downstream of pump between pump and isolation valves.
9. Provide an air vent in the casing of 1 HP and larger pumps.
10. Provide vertical shaft-type sump pumps with the motor located above the sump.
11. Condensate pumps: Preferred floor mounted, cast iron casing type. Select pump and pump seals for 210º F water without flashing for large condensate applications.

Installation, Fabrication and Construction

1. Specify each pump with separate balancing valves in the discharge piping so the design flow rate may be set.
2. Provide each pump with check valves, isolating valves and unions or flanges for easy service removal.
3. Provide all pumps with inlet strainers as part of the piping or pump inlet accessories.
4. Grout pump base to the concrete equipment pad or inertia base for floor mounted pumps.
5. For floor mounted condensate pumps, provide a sight glass and vent. Terminate vent to the outdoor. If an outdoor termination is not convenient, pipe the vent a minimum of 4 feet vertically and terminate at a drain.
6. Provide isolation valves between condensate pumps and condensate receiver.
7. Minimize pipe/pump flexible connections.
8. Verify pump alignment and submit alignment data.

W. Testing, Adjusting and Balancing

Design Criteria

1. Check with the UW Project Manager to see if the TAB services are to be provided by the Contractor as part of the construction contract commissioning service or to be hired directly by the UW under a separate contract.
2. Give special consideration to the TAB process during the design so that a technician can test and analyze the particular installation and properly balance the system to obtain the greatest system efficiency and comfort level. It is important that balancing capability be designed into the system.
3. On systems with variable frequency drives (VFD) the fan and pump design performance needs to be accomplished with the VFD operating at 55 to 58 HZ as the standard VFD arrangement unless specifically directed otherwise by the contract documents. Provide the necessary sheave replacements and pump impeller trim to achieve this arrangement.
4. Specify that Testing Adjusting and Balancing is performed in accordance with current NEBB or AABC requirements. Balancers must be affiliated by qualification with NEBB or AABC.
5. Specify the scope of Testing, Adjusting, and Balancing in the project contract documents.

Construction Submittals

Balance Report submittals

<u>Preliminary submittal</u>

1. Draft report for review by the A/E, Commissioning Agent, and UW Engineering Services that includes the following:
   a. A list of items that prevents the balancer from providing a full and complete balance or testing.
   b. Narratives that describe all problem areas that may require major construction or design changes.
   c. Narratives that describe the building systems and control systems to demonstrate comprehension of system operation, including system diversity.
   d. The balancing agenda which reiterates the scope of the balancing work and the intended order of activity.
   e. Sample balancing data sheets

<u>Final submittal</u>

1. Certified Testing Adjusting and Balancing report that includes the following:
   a. Completed balancing data sheets.
   b. Drawings annotated to indicate inlet and outlet numbering that corresponds to the balancing data sheets.

c. Narratives that describe the building systems and control systems including system diversity.
d. Narrative description of those items not conforming to the contract requirements.

X. Water Treatment and Flushing

Design Criteria

1. Provide cooling tower water treatment controller per Preferred Vendors list.
2. Provide catalog cut sheets including SDS data sheets for chemicals used. List the name and chemical content of all additives, the amount to be added to each piping system, the total volume of each system and schedule of chemical feed.
3. Submit a flushing and water treatment plan for each system. Include data sheets for equipment to be provided and parameters set for the procedure; such as media used for flushing, pressure, velocity, temperature, and duration.
4. Conduct and submit initial water quality analysis to ensure the onsite water supply is within reasonable expected conditions and as a basis for the overall chemical treatment program.
5. Provide polypropylene glycol for systems subject to freezing. Submit a report of the manufacturer and specific chemical contents of all additives, the amounts added, the total volume of the system, and the rated freezing temperature for the specified concentration.
6. Provide a schedule indicating total volume of each system and targeted tolerable range of test results.
7. Provide a list of piping systems requiring chemical treatment and specify treatment.
8. Chemical treatment report to include pipe volume for each hydronic system. In addition, the report is to include the total bacteria, corrosion rates and meter readings.
9. Provide a pot feeder, a coupon rack and a make-up water meter for each hydronic system, (except chilled water system not decoupled from the CCW)

Installation, Fabrication and Construction

General

1. Submit a flushing and water treatment plan and integrate the tentative schedule in the construction outlook plan.
2. Maintain a set of drawings on-site for recording and sign-off of each flushed and/or treated section or system. All flushing/cleaning and treatment to be observed and documented with results approved by an Owner representative.
3. After each day of flushing/cleaning and treatment, submit to the Owner a copy of the paperwork recording the raw data, designating the piping system and Pipe Code, and comparing the allowable and actual results.
4. Central Cooling Water is treated by the University at the Central Power Plant and West Campus Utility Plant. For CCW treatment, fill the CCW system with clean water and notify Engineering Services and the Central Power Plant of the system startup date and total system volume.
5. For closed-loop hydronic systems, label total water volume (in gallons) and glycol concentration (in %) near pot feeder.

Flushing/Cleaning and Treatment Methods

1. Special procedures or temporary modifications may be required to ensure all parts of the system are flushed and receive chemical treatment. Pay particular attention to piping dead legs and back-up equipment (back-up chiller, back-up pumps, etc.). Return all systems to intended operating conditions after successful completion of the procedure.
2. Hydrostatic or water flush: Use clean, fresh city water. On gas piping, remove water from the entire systems after flushing and use the following pneumatic cleaning method to dry the system.
3. Pneumatic cleaning: Blow clean, dry and oil-free air or nitrogen through the system.
4. Water flush: Flush piping with water at a velocity of 6 ft/s until effluent is clean and contains no visible particulate matter. Provide flow measurement in flushing water supply line to be used as basis for verification of flow velocities in piping system. Clean all strainers after flushing.
5. For CCW, perform the system pressure test and flushing in the presence of Engineering Services. CCW cannot be used for flushing. Provide temporary pumps, to flush the system with water at a velocity of 5 to 6 feet per second. Piping to be filled with clean water after flush and prior to opening valves. Notify Power Plant personnel to open the valves to the main CCW system after approval by Engineering Services
6. Extension of water treatment program: Continue the treatment program for a period of one year following the date when the system is put into intended normal operation. The extended program includes monthly water quality tests, reports, and scheduled chemical feed to maintain water quality within tolerable ranges.
7. The following table lists the typical piping system, pipe code and corresponding recommended cleaning method:

Piping System	Cleaning Method
Acid Resistant Waste	-
Carbon Dioxide	Pneumatic
Central Cooling Water	Water Flush
Coil Condensate	Water Flush
Compressed Air (Laboratory)	Pneumatic
Compressed Air (Pneumatic)	Pneumatic
Condenser Water	Water Flush
Fire Protection	(1)
Heating Hot Water	Water Flush

Piping System	Cleaning Method
Helium Recovery	Pneumatic
Irrigation	Water Flush
Laboratory Cold Water	Water Flush (3)
Laboratory Hot Water	Water Flush (3)
Laboratory Hot Water Circulation	Water Flush (3)
Laboratory Vacuum	Pneumatic
Lake Water	Water Flush
Medical Gas	Pneumatic (2)
Medical Vacuum	Pneumatic (2)
Natural Gas	Pneumatic (2)
Nitrogen	Pneumatic
Oxygen	Pneumatic (2)
Potable Cold Water	Water Flush (3)
Potable Hot Water	Water Flush (3)
Potable Hot Water Circulation	Water Flush (3)
Process Chilled Water	Water Flush
Propane	Pneumatic
Refrigerant Liquid	Pneumatic
Refrigerant Suction	Pneumatic
Reverse Osmosis/De-ionized Water (High Purity)	Water Flush
Sea Water	Water Flush
Steam (Low Pressure)	Water Flush
Steam (Medium Pressure)	Water Flush

Piping System	Cleaning Method
Steam (High Pressure)	Water Flush
Steam Condensate	Water Flush
Tempered Water (Safety Shower/Eyewash)	Water Flush
Trap Primer	Water Flush
Well Water	Water Flush

(1) Refer to NFPA and Environmental, Health & Safety - Fire Protection System section for information.
(2) Refer to NFPA for additional information.
(3) Refer to City/County Department of Public Health for cleaning, disinfection, bacteriological testing, and additional information. Contact Owner prior to testing.

Mechanical Metering – Purchase Specs

23 05 19.11 Steam Condensate or Hot Water Meter – Purchase Spec

PART 1 – GENERAL

1.02 DESCRIPTION

A. Purpose

1. This section covers steam condensate meters, steam condensate sub-meters and hot water sub-meters for use in the Owner's steam systems.

1.03 QUALIFICATIONS

A. Approved manufacturers

1. Steam Condensate Meters and Sub-Meters
    a. Central Station Steam Co. – Cadillac Magnetic Flow Meter, no exceptions allowed
2. Hot Water BTU Sub-Meter
    a. Btu Meter
        i. Central Station Steam Co. – Cadillac Heatx-2 BTU Meter, no exceptions allowed
    b. Flow Meter
        i. Central Station Steam Co. – Cadillac Magnetic Flow Meter, no exceptions allowed
3. Conductivity Sensor
    a. Sensorex – CS675HTTC for 3" C and smaller conduit
    b. Sensorex – CS676HTTC for 4" C and 6" C
    c. Or Approved Equal
4. Conductivity Transmitter
    a. Sensorex – Con500
    b. Or Approved Equal
5. Temperature Transmitter
    a. Pyromation – 440 Series
    b. Or Approved Equal
6. Thermowell with Sensor

a. Pyromation – R1T185L
b. Or Approved Equal

7. Twisted-pair shielded cable

a. Belden 88760
b. Or Approved Equal

1.04 RELATED SECTIONS

A. 01 91 00 – General Commission Requirements
B. Section 23 08 00.11 – Mechanical Meter Integration and Commission
C. Section 26 09 13.11 – Data Collection Controller

1.05 REFERENCES

A. Applicable codes, standards, and references codes, regulations and standards

1. ANSI B16.5 Class 150 RF
2. AWWA Class B
3. NEMA 4X/6P (IP66/IP67)
4. CSA
5. State and local codes and ordinances

1.06 COORDINATION

A. Coordinate Operations and Maintenance training times with the Owner.
B. Coordinate the quantity and location of Facility Network (Facnet) Ethernet ports with Campus Engineering & Operations and UWIT. Contractor shall provide a completed "Mechanical Meter Profile Report" form per Specification 23 08 00.11 Appendix A for each meter.

1.07 SUBMITTALS

A. General

1. Submittals shall be in accordance with Conditions of the Contract and Division 01 Specification Sections.
2. Submit detailed maintenance manuals and drawings, which include catalog information indicating the complete electrical and mechanical characteristics.
3. Submit dimensioned cross-sectional drawings (manufacturer's data sheets are acceptable).
4. Submit finished meter tests – Manufacturer's Certified Test Reports showing accuracy tests

1.08 OPERATIONS AND MAINTENANCE (O&M) MANUALS

A. Operations and Maintenance Manuals shall be in accordance with Conditions of the Contract and Division 01 Specification Sections.

B. Operations and Maintenance Manuals shall include catalog information indicating complete electrical and mechanical characteristics.
C. Manufacturer's Certified Test Reports
D. Manufacturer's drawings of meter wiring diagram.

1.09 MEETINGS

A. Pre-installation conference
   1. The Contractor shall request a pre-installation conference with the UW Engineering Services and UW Power Plant Personnel for steam projects
B. Attend meetings with the Owner and/or Owner's Representative as required to resolve any installation or functional problems.

PART 2 – PRODUCTS

2.02 GENERAL

A. These steam condensate meter specifications are in accord with the Owner's policy to construct permanent installations with long life, coupled with maximum reliability and safety.

2.03 STEAM CONDENSATE METER

A. The following shall apply to the steam condensate main meters and sub-meters installed on the UW Campus:
   1. Steam condensate meter shall operate by electromagnetic induction principle.
      a. Meter shall accept 120V AC power source.
   2. Steam condensate meter shall measure and report the following quantities at a minimum:
      a. Instantaneous and totalized flow
   3. Meter fluid temperature range
      a. 14°F to 248°F with integral electronics, PFA liner, and Hastelloy C electrodes
      b. 14°F to 356°F with remote electronics, PFA liner, and Hastelloy C electrodes
   4. Steam condensate meter shall have digital display and totalization for local monitoring
   5. Steam condensate meter shall have a minimum of 2 pulse and analog (4-20mA) outputs for remote monitoring
   6. Meter electronics shall be housed in a NEMA 4X enclosure.
   7. Meter shall be suitable for installations on pipes sizes from 0.5" to 48" diameters.
   8. Meter Body
      a. The meter will consist of a full bore body with encapsulated and rigidly retained set of coils.

b. The meter body shall be constructed of 316 stainless steel, and rated for a maximum allowable non-shock pressure and temperature for steel pipe flanges, according to ANSI B16.5.
c. The meter body end connections shall be carbon steel or 316 stainless steel flanged, according to ANSI B16, Class 150 and AWWA Class B standards.
d. The meter body shall be available in ANSI Class 150 or Class 300 ratings.

2.04 HOT WATER BTU SUB-METER

A. The following shall apply to hot water BTU sub-meters installed on the UW Campus:

1. BTU meter shall be provided with two temperature sensors.
   a. Temperature sensors shall have a differential temperature accuracy of +/- 0.15 degree F over the calibrated range
2. BTU meter shall have the following accuracy:
   a. +/- 1.0% of reading from 2 to 20 ft/sec
   b. +/- 0.02 ft/sec below 2 ft/sec
3. BTU meter shall be capable of receiving a 0-15V pulse input from a flow meter.
4. BTU meter shall accommodate fluid temperature range
   a. 32°F to 200°F Standard
   b. 120°F to 300°F Optional
5. BTU meter shall have digital display and totalization for local monitoring. Local display shall include supply temperature, return temperature, gallons per minute (GPM), btu/hr, gallons and btu (dual mode).
6. BTU meter shall have an isolated solid state dry contact for energy totalization.
7. Meter electronics shall be housed in a NEMA 4X enclosure.
8. Meter shall be suitable ambient temperatures of -20 to 140° F.
9. Meter shall be provided with memory retention of program parameters in the event of a power loss.
10. BTU meter shall accommodate a 120V AC source.
11. BTU meter shall have a RJ45 port with BACNet IP communication protocol.
12. BTU meter shall have 2 4-20mA analog inputs available.

2.05 HOT WATER FLOW SUB-METER

A. The following shall apply to the hot water flow sub-meters installed on the UW Campus:

1. Meter shall operate by electromagnetic induction principle.
   a. Meter shall accept 120V AC power source.
2. Meter shall measure and report the following quantities at a minimum:
   a. Instantaneous and totalized flow
3. Meter fluid temperature range

a. 14°F to 248°F with integral electronics, PFA liner, and Hastelloy C electrodes
b. 14°F to 356°F with remote electronics, PFA liner, and Hastelloy C electrodes

4. Meter shall have digital display and totalization for local monitoring
5. Meter shall have a minimum of 2 pulse and analog (4-20mA) outputs for remote monitoring
6. Meter electronics shall be housed in a NEMA 4X enclosure.
7. Meter shall be suitable for installations on pipes sizes from 0.5” to 48” diameters.
8. Meter Body

a. The meter will consist of a full bore body with encapsulated and rigidly retained set of coils.
b. The meter body shall be constructed of 316 stainless steel, and rated for a maximum allowable non-shock pressure and temperature for steel pipe flanges, according to ANSI B16.5.
c. The meter body end connections shall be carbon steel or 316 stainless steel flanged, according to ANSI B16, Class 150 and AWWA Class B standards.
d. The meter body shall be available in ANSI Class 150 or Class 300 ratings.

2.06 ACCESSORIES

A. Conductivity Sensor

1. Capable of operating in fluid temperature of 0°F to 356°F
2. Constructed of ¾” NPT stainless steel body and pins
3. 6” PTFE coated wire leads
4. Maximum operating pressure of 250 psig

B. Conductivity Transmitter

1. Shall accommodate six (6) selectable conductivity ranges
2. Accuracy shall be +/- 1% of full scale reading in respective range
3. Housing shall be NEMA 4X
4. Capable of converting Pt100 input signal into a 4-20 mA analog output signal.

C. Thermowell Temperature Sensor

1. Capable of operating in fluid temperature of -50°F to 356°F
2. Constructed of stainless steel or corrosion resistant material
3. 3-wire spring loaded element capable of transmitting a Pt100 signal
4. ¼” Sheath diameter
5. Head mounted RTD transmitter capable of converting Pt100 input signal into a 4-20 mA analog output signal and an upscale burnout
6. Shall have stainless steel ½” x ½” NPT hex nipple 1” length fittings to thermowell

D. Thermowell

1. Shall be standard duty.
2. Shall be ¾” pipe size.
3. Constructed of stainless steel.

4. Shall accept a ½" NPT connection

2.07 STEAM CONDENSATE AND HOT WATER DATA COLLECTION CONTROLLER

A. Refer to Section 26 09 13.11 Data Collection Controller

PART 3 – EXECUTION

3.02 REQUIREMENTS

A. Application

1. Main meter shall be provided and installed as a complete steam condensate meter system including accessories to measure flow, conductivity and temperature in the main steam condensate pipe service.
2. Sub-meters shall be provided and installed as required by code and rating system credits per project.

B. General installation

1. Identification

a. Reference section 23 05 53 Identification of Mechanical Piping and Equipment

2. Installation

a. Only personnel qualified and experienced in this type of work shall make connections.
b. The installation of meters shall be done with care to avoid damage.

i. Meters showing damage after installation shall be replaced.
ii. Meters shall have adequate clearance to service, repairs, and replacement.
iii. Data collection cabinets hung improperly shall be properly secured and all paint scratches shall be touched up.

c. Provide adequate pipe diameters upstream and downstream of installed meter. See Manufacturer's recommendations.
d. Each hot water BTU sub-meter shall have dedicated CAT5E communication cable installed to connect the meter to the facility network. Install communication cable in rigid conduit.
e. Meters shall be installed such that the display can be easily read. A shield shall be supplied if display is in direct sunlight.
f. On gravity flow applications, install a loop seal.
g. Each steam condensate meter shall have a dedicated twisted-pair shielded cable installed for each 24VDC digital pulse out to the data collection controller.
h. Each steam condensate conductivity or temperature transmitter shall have dedicated twisted-pair shielded cable installed to transmit the 4-20 mA signal to the data collection controller.
i. Meters shall be installed such that the display can be easily read.

j. Provide shutoff valves and a bypass connection to allow for continuous service during periods of meter maintenance.
k. Provide appropriate installation kit based upon pipe material.
l. See Attachment #1 for typical wiring configuration.

3. UW's Power Plant Department will check the Contractor's work to ensure the accuracy of the installation.

   a. The Contractor shall arrange with the Owner for the times when Owner's services will be required, and under no circumstances shall the Contractor connect to the existing system without Owner's knowledge.
   b. The proper connection of the wires and cables to other systems as specified is entirely the responsibility of the Contractor.
   c. Contractor shall not energize meter until Owner has inspected wiring.

4. Install meters per manufacturer's recommendations.
5. Meter shall be UL Listed from manufacture or shall be field listed.

C. Mounting and electrical connections

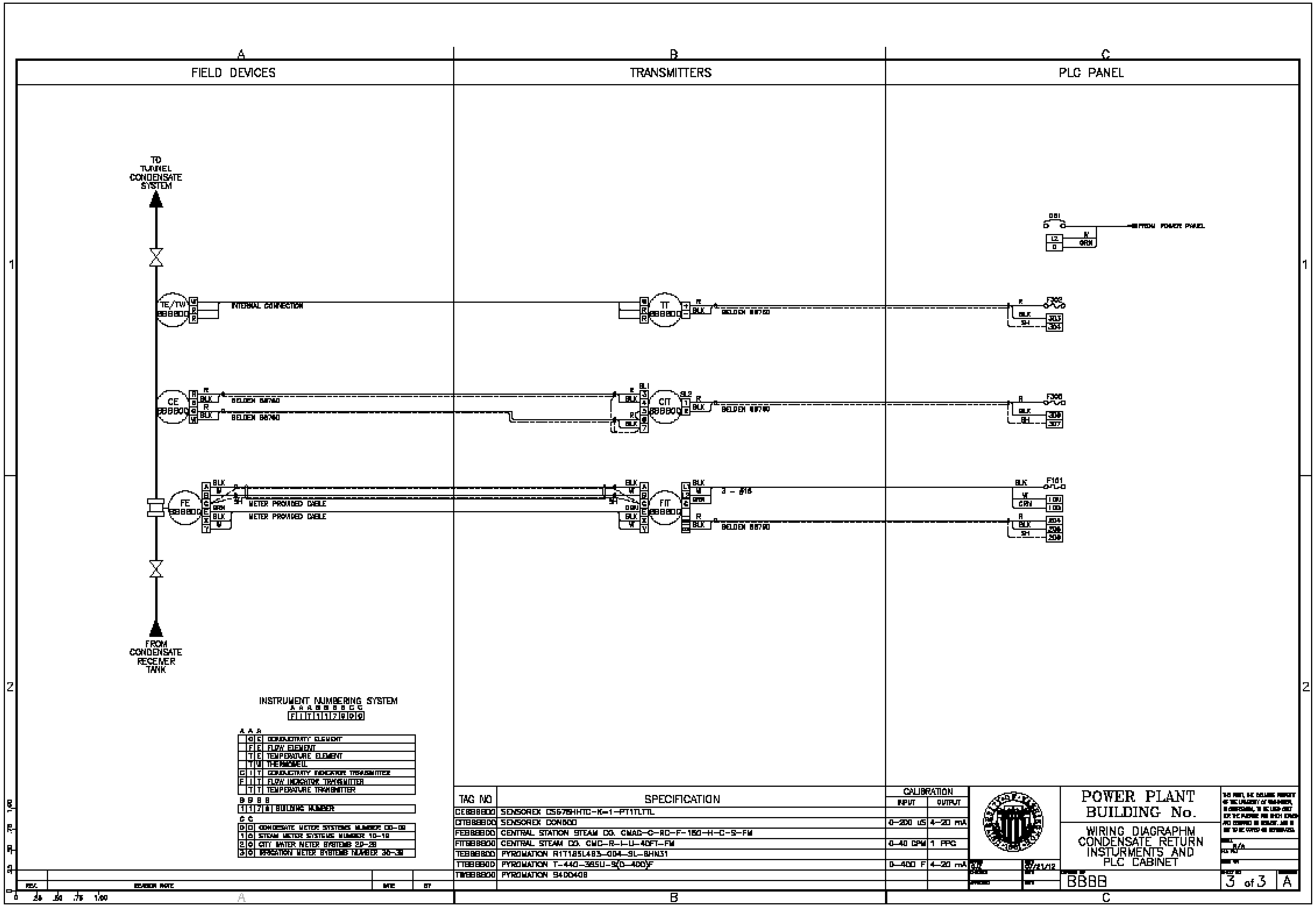
1. In accordance with manufacturer's installation instructions.
2. Install a dedicated 120V circuit per Specification 26 09 13.11 to the Data Collection Controller to provide low-voltage power to the steam condensate meter and transmitters.
3. Install 24V circuits from the Data Collection Controller to the steam condensate meter and transmitters.
4. Install 24V circuits from the hot water Btu Meter to flow meter and transmitters.
5. 24V circuit shall be THWN or XHHW insulation and installed in a GRC/IMC conduit. A 'C' condulet is to be used when transitioning from conduit to device. Flexible conduit shall be jacketed metallic "sealtite" style with enough slack to allow for the removal of the device.

D. Testing

1. Contractor to verify meter is reading accurately.

E. Integration and Commissioning

1. See section 23 08 00.11 Mechanical Meter Integration and Commissioning


FIELD DEVICES
TRANSMITTERS
PLC PANEL
TO TUNNEL CONDENSATE SYSTEM
FROM CONDENSATE RECEIVER TANK
INTERNAL CONNECTION
BELDEN 88760
METER PROVIDED CABLE
INSTRUMENT NUMBERING SYSTEM
CE CONDUCTIVITY ELEMENT
FE FLOW ELEMENT
TE TEMPERATURE ELEMENT
TW THERMOWELL
CIT CONDUCTIVITY INDICATOR TRANSMITTER
FIT FLOW INDICATOR TRANSMITTER
TT TEMPERATURE TRANSMITTER
TAG NO
SPECIFICATION
CALIBRATION
INPUT
OUTPUT
POWER PLANT
BUILDING No.
WIRING DIAGRAPHM
CONDENSATE RETURN
INSTURMENTS AND
PLC CABINET
BBBB
3 of 3
A

23 05 19.21 Central Cooling Water Meter – Purchase Spec

PART 1 – GENERAL

1.01 DESCRIPTION

A. Purpose

1. This section covers central cooling water meters for use in the Owner's central cooling water systems.

1.02 QUALIFICATIONS

A. Approved manufacturers

1. BTU Meter
    a. Onicon Incorporated – System-10 BTU Meter
    b. Central Station Steam Co – Cadillac Heatx-2 BTU Meter
    c. Spire Metering Technology – SpireMag T-Mag BTU Meter
2. Central Cooling Water Flow Tube Meter – New Construction
    a. Onicon Incorporated – F-3100 Series
    b. Central Station Steam Co – Cadillac CMAG
    c. Spire Meter technology – MAG888
3. Central Cooling Water Insertion Meter – Retrofit Existing Meters
    a. Onicon Incorporated – F-3500 Series
    b. Central Station Steam Co – Cadillac CMAG
    c. Spire Metering Technology – SpireMag T-Mag Insertion Sensor

1.03 RELATED SECTIONS

A. 01 91 00 – General Commission Requirements
B. 23 08 00.11 – Mechanical Meter Integration and Commission
C. 26 09 13.11 – Data Collection Controller

1.04 REFERENCES

A. Applicable codes, standards, and references codes, regulations and standards

1. NEMA 4X/6P (IP66/IP67)
2. State and local codes and ordinances

1.05 COORDINATION

A. Coordinate Operations and Maintenance training times with the Owner.
B. Coordinate the quantity and location of Facility Network (Facnet) Ethernet ports with Campus Engineering & Operations and UWIT. Contractor shall provide a completed

"Mechanical Meter Profile Report" form per Specification 23 08 00.11 Appendix A for each meter.

1.06 SUBMITTALS

A. General

1. Submittals shall be in accordance with Conditions of the Contract and Division 01 Specification Sections.
2. Submit detailed maintenance manuals and drawings, which include catalog information indicating the complete electrical and mechanical characteristics.
3. Submit dimensioned cross-sectional drawings (manufacturer's data sheets are acceptable).
4. Submit finished meter tests – Manufacturer's Certified Test Reports showing accuracy tests

1.07 OPERATIONS AND MAINTENANCE (O&M) MANUALS

A. Operations and Maintenance Manuals shall be in accordance with Conditions of the Contract and Division 01 Specification Sections.
B. Operations and Maintenance Manuals shall include catalog information indicating complete electrical and mechanical characteristics.
C. Manufacturer's Certified Test Reports
D. Manufacturer's drawings of meter wiring diagram.

1.08 MEETINGS

A. Pre-installation conference

1. The Contractor shall request a pre-installation conference with the UW Engineering Services for central cooling water projects

B. Attend meetings with the Owner and/or Owner's Representative as required to resolve any installation or functional problems.

PART 2 – PRODUCTS

2.01 GENERAL

A. These central cooling water meter specifications are in accord with the Owner's policy to construct permanent installations with long life, coupled with maximum reliability and safety.

2.02 BTU METER

A. The following shall apply to the BTU meters installed on the UW Campus:

1. BTU meter shall be provided with two temperature sensors.

a. Temperature sensors shall have a differential temperature accuracy of +/- 0.15 degree F over the calibrated range

2. BTU meter shall have the following accuracy:
   a. +/- 1.0% of reading from 2 to 20 ft/sec
   b. +/- 0.02 ft/sec below 2 ft/sec
3. BTU meter shall be capable of receiving a 0-15V pulse input from a flow meter.
4. BTU meter shall accommodate fluid temperature range
   a. 32°F to 200°F Standard
   b. 120°F to 300°F Optional
5. BTU meter shall have digital display and totalization for local monitoring. Local display shall include supply temperature, return temperature, gallons per minute (GPM), btu/hr, gallons and btu (dual mode).
6. BTU meter shall have an isolated solid state dry contact for energy totalization.
7. Meter electronics shall be housed in a NEMA 4X enclosure.
8. Meter shall be suitable ambient temperatures of -20 to 140° F.
9. Meter shall be provided with memory retention of program parameters in the event of a power loss.
10. BTU meter shall accommodate a 120V AC source.
11. BTU meter shall have a RJ45 port with BACNet IP communication protocol.
12. BTU meter shall have 2 4-20mA analog inputs available.

2.03 CENTRAL COOLING WATER FLOW TUBE METER

A. The following shall apply to central cooling water in-line magnetic flow meters installed on the UW Campus

1. In-line magnetic flow meter shall use electromagnetic sensing method.
2. Meter shall have a flow range of 0.10 ft/sec to 33 ft/sec.
3. Meter shall have a reading accuracy as follows:
   a. +/- 0.4% for velocities between 3.3 ft/sec and 33 ft/sec
   b. +/- 0.75% for velocities between 1 ft/sec and 3.3 ft/sec
4. Meter shall have empty pipe detection
5. Meter shall measure fluids with conductivity greater than or equal to 5.0 uS/cm
6. Meter shall have an option for bidirectional flow
7. Meter shall have a stainless steel internal flow tube.
8. Meter body shall be constructed of stainless steel.
9. Meter shall be capable of ANSI Class 150 flange connections, with the option of ANSI Class 300 flange connections
10. Meter shall be provided with ground rings for each side
11. Meter shall have a maximum operating pressure of 230-580 psi depending flange rating
12. Meter shall be suitable for installations on pipes from 1” to 48”
13. Meter shall accommodate fluid temperature range

   a. 32°F to 200°F Standard
   b. 120°F to 300°F Optional

14. Meter electronics shall be housed in a NEMA 4X enclosure.
15. Meter shall be suitable for ambient temperatures of 0 to 140° F.
16. Meter shall have a local digital display that indicates total flow, flow rate, flow direction and alarm conditions
17. Meter shall have non-volatile memory for retention of program parameters and totalized values.
18. Meter shall be equipped with a 4-20 mA analog output for flow rate
19. Meter shall have a programmable digital/pulse outputs.
20. Meter shall accommodate 120V AC power source.

2.04 CENTRAL COOLING WATER INSERTION FLOW METER

A. The following shall apply to central cooling water insertion flow meters installed on the UW Campus

1. Insertion flow meter shall use electromagnetic sensing method.
2. Meter shall have a flow range of 0.10 ft/sec to 20 ft/sec
3. Meter shall have a reading accuracy as follows:
   a. +/- 1% for velocities between 2 to 20 ft/sec
   b. +/- 0.02 ft/sec for velocities below 2 ft/sec
4. Meter shall have a conductivity range of 20 to 60,000 uS/cm
5. Meter shall have turndown that exceeds 80:1
6. Meter shall be capable of being installed in the upper 240 degrees of a horizontal pipe
7. Meter shall accommodate pipes sizes from 3” to 72”
8. Meter shall have a pressure drop of less than 0.1 psi at a velocity of 12 ft/sec in pipes 3” and larger.
9. Meter shall have an operating pressure of 400 psi
10. Meter shall be able to accommodate liquid temperatures from 32 to 200° F
11. Meter shall be suitable for ambient temperatures of -20 to 140° F.
12. Meter shall have 0-15V pulse output
13. Meter shall be equipped with a 4-20 mA analog output for flow rate
14. Meter shall be equipped with an isolated solid dry contact for energy totalization
15. Meter electronics shall be housed in a NEMA 4X housing
16. Meter shall accommodate 120V AC power source.

PART 3 – EXECUTION

3.01 REQUIREMENTS

A. Application

1. Central Cooling Water meter system shall be provided and installed on the main CCW pipe services to each building.

B. General installation

1. Identification
    a. Reference section 23 05 53 Identification of Mechanical Piping and Equipment
2. Installation
    a. Only personnel qualified and experienced in this type of work shall make connections.
    b. The installation of meters shall be done with care to avoid damage.
        i. Meters showing damage after installation shall be replaced.
        ii. Meters shall have adequate clearance to service, repairs, and replacement.
        iii. Data collection cabinets hung improperly shall be properly secured and all paint scratches shall be touched up.
    c. Provide adequate pipe diameters upstream and downstream of installed meter. See Manufacturer's recommendations.
    d. Each BTU meter shall have dedicated CAT5E communication cable installed to connect the meter to the facility network (Facnet). Install communication cable in rigid conduit.
    e. Meters shall be installed such that the display can be easily read. A shield shall be supplied if display is in direct sunlight.
    f. Provide shutoff valves and a bypass connection as necessary to allow for continuous service during periods of meter maintenance.
    g. Provide weldolet and ½" NPT brass thermos wells (for less than 6" pipe) or ½" NPT stainless steel thermos wells (for pipe 6" of larger) for installation of insertion flow meter.
    h. Provide Pete's Plugs adjacent to each temperature sensors to provide owner a test point for the temperature sensors.
    i. Provide appropriate installation kit based upon pipe material.
    j. Provide adequate slack in flexible communication conduit to allow for the removal of the flow meter.
3. UW's Power Plant Department will check the Contractor's work to ensure the accuracy of the installation.
    a. The Contractor shall arrange with the Owner for the times when their services will be required, and under no circumstances shall the Contractor connect to the existing system without Owner's knowledge.
    b. The proper connection of the wires and cables to other systems as specified is entirely the responsibility of the Contractor.
    c. In the event the connections cannot be made as specified, the Contractor shall make the necessary corrections at his own expense.
4. Install meters per manufacturer's recommendations.

5. Meter shall be UL Listed from manufacture or shall be field listed.

C. Mounting and electrical connections

1. In accordance with manufacturer's installation instructions.
2. Install a dedicated 120V circuit from the power source to the BTU meter to provide power to the meters and temperature sensors. Install 120V circuit in rigid conduit.
3. Install 24V circuits from the BTU meter to each flow meter and temperature sensor.
4. 24V circuit shall be THWN or XHHW insulation and installed in a rigid conduit to a junction box located next to the meter. A flexible conduit shall be connected from the junction box to the meter with enough slack to allow for removal of the meter.

D. Testing

1. Contractor to verify meter is reading accurately.

E. Integration and Commissioning

1. See section 23 08 00.11 - Mechanical Meter Integration and Commissioning

23 05 19.31 Sewer Submeter – Purchase Spec

PART 1 – GENERAL

1.01 DESCRIPTION

A. Purpose

1. This section covers sewer submeters for use in the Owner's water systems.

1.02 QUALIFICATIONS

A. Approved manufacturers

1. Cooling Tower Sewer Submeter (Deduct and Charge)
    a. Badger Meter – E-Series Ultrasonic Meter up to 2”
    b. Master Meter – Octave Ultrasonic Meter larger than 2”
2. Irrigation Sewer Submeter (Deduct)
    a. Sensus – accuMAG Meter
3. Twisted-pair shielded cable
    a. Belden 88760
    b. Or Approved Equal

1.03 REFERENCES

A. Applicable codes, standards, and references codes, regulations and standards

1. NSF/ANSI Standard 61
2. NSF/ANSI Standard 372
3. AWWA C700 Standards
4. AWWA C701 Class 2 Standards
5. SPU Sewer Submeter Technology Requirements
6. State and local codes and ordinances

1.04 COORDINATION

A. Coordinate Operations and Maintenance training times with the Owner.
B. Contractor shall provide a completed “Mechanical Meter Profile Report” form per Specification 23 08 00.11 Appendix A for each meter.

1.05 SUBMITTALS

A. General

1. Submittals shall be in accordance with Conditions of the Contract and Division 01 Specification Sections.

2. Submit detailed maintenance manuals and drawings, which include catalog information indicating the complete electrical and mechanical characteristics.
3. Submit dimensioned cross-sectional drawings (manufacturer's data sheets are acceptable).
4. Submit SPU meter acceptance verification of meter. SPU acceptance of meter must be obtained prior to purchase of meters.
5. Submit finished meter tests – Manufacturer's Certified Test Reports showing accuracy tests

1.06 OPERATIONS AND MAINTENANCE (O&M) MANUALS

A. Operations and Maintenance Manuals shall be in accordance with Conditions of the Contract and Division 01 Specification Sections.
B. Operations and Maintenance Manuals shall include catalog information indicating complete electrical and mechanical characteristics.
C. Manufacturer's Certified Test Reports
D. Manufacturer's drawings of meter wiring diagram.

1.07 MEETINGS

A. Pre-installation conference

1. The Contractor shall request a pre-installation conference with the UW Engineering Services water projects

B. Attend meetings with the Owner and/or Owner's Representative as required to resolve any installation or functional problems.

PART 2 – PRODUCTS

2.01 GENERAL

A. These sewer submeter specifications are in accord with the Owner's policy to construct permanent installations with long life, coupled with maximum reliability and safety.

2.02 SEWER SUBMETER

A. The following shall apply to the sewer submeters installed on the UW Campus:

1. Sewer submeter shall have the following accuracy:

    a. Minimum 95% accuracy for low flow rates
    b. 100 +/- 1.5% for normal operating flow

2. Sewer submeter shall measure in cubic feet (CF) and broadcast in 100 cubic feet (CCF)
3. Sewer submeter shall have a permanently sealed direct reading registers and encoders.
4. Sewer submeter shall accommodate a flow rate of 0.1 ft/sec to 33 ft/sec
5. Sewer submeter shall be made of lead-free material.
6. Sewer submeter shall have an operating range as follows:

Sewer submeter		
Size	Operating Range (GPM)	Extended Low-Flow
5/8”, 5/8”x3/4”	1/8 to 25 GPM	0.1 GPM
¾”, ¾”x1”	3/8 to 35 GPM	0.1 GPM
1”	½ to 55 GPM	0.4 GPM
1 ½”	1 ¼ to 120 GPM	0.4 GPM
2”	1 ½ to 170 GPM	0.5 GPM

7. Sewer submeter shall have a maximum pressure loss of 8 psi at the maximum continuous flow of the meter. Sewer submeter shall have a maximum operating pressure of 150 psi.
8. Sewer submeter shall be suitable ambient temperatures of -20 to 1200 F. Sewer submeter shall have a display for local meter reading
9. Sewer submeter shall be capable of AMR communication with Itron’s data collection systems.
10. Sewer submeter shall not require the use of a strainer
11. Sewer submeter for installation on a cooling tower drain/blowdown shall be able to withstand any particulate that may be discharged.

Sewer submeter shall supplied with 100W Itron ERT. The ERT must be programmed in “hard-to-read” mode.

PART 3 – EXECUTION

3.01 REQUIREMENTS

A. Application

1. Provide sewer submeters on each of the following sub-systems:
    a. Irrigation (Deduct)
    b. Cooling Tower Makeup (Deduct)
    c. Cooling Tower Blowdown/Drain (Charge)

B. General installation

1. Identification
    a. Reference section 23 05 53 Identification of Mechanical Piping and Equipment
2. Installation

a. Only personnel qualified and experienced in this type of work shall make connections.
b. The installation of meters shall be done with care to avoid damage.
    i. Meters showing damage after installation shall be replaced.
    ii. Meters shall have adequate clearance to service, repairs, and replacement.
    iii. Data collection cabinets hung improperly shall be properly secured and all paint scratches shall be touched up.
c. Provide adequate pipe diameters upstream and downstream of installed meter. See Manufacturer's recommendations.
d. Meters shall be installed such that the display can be easily read by a person without crawling under mechanical equipment or up on ladders to see the face of the meter. A shield shall be supplied if display is in direct sunlight.
e. Provide appropriate installation kit based upon pipe material.
f. Provide adequate slack in flexible communication conduit to allow for the removal of the sewer submeter.
g. Ensure AMR signal can be read by an Itron data collection system from the Seattle Public Utility's normal meter reading route.
h. On cooling tower fill lines, install meters such that no hose bibbs or other unrelated water uses are installed between the meter and the cooling tower inlet.

3. UW will check the Contractor's work to ensure the accuracy of the installation.
    a. The Contractor shall arrange with the Owner for the times when their services will be required, and under no circumstances shall the Contractor connect to the existing system without Owner's knowledge.
    b. The proper connection of the wires and cables to other systems as specified is entirely the responsibility of the Contractor.
    c. In the event the connections cannot be made as specified, the Contractor shall make the necessary corrections at his own expense.
4. Install meters per manufacturer's recommendations.

C. Mounting and electrical connections
1. In accordance with manufacturer's installation instructions.
2. Chargeable meters shall be mounted horizontally unless an alternate configuration is approved by the manufacturer and will measure accurately.
3. Cooling tower gravity drain/blowdown meters shall be installed with a loop seal, also known as an inverted pea trap. Install electric heat trace on the flooded portion of the loop seal for freeze protection over winter.

D. Testing
1. Contractor to verify meter is reading accurately.
2. Contractor to submit meter accuracy report of verified meter reading.

23 05 19.41 Building Water Meter – Purchase Spec

PART 1 – GENERAL

1.01 DESCRIPTION

A. Purpose

1. This section covers building water meters and sub-meters for use in the Owner's water systems.

1.02 QUALIFICATIONS

A. Approved manufacturers

1. UW Water Meter and Sub-Meters

    a. Cadillac Meter – CMAG Magnetic Flow Meter w/ Integral Converter

2. Twisted-pair shielded cable

    a. Belden 88760
    b. Or Approved Equal

1.03 RELATED SECTIONS

A. 01 91 00 – General Commission Requirements
B. Section 23 08 00.11 – Mechanical Meter Integration and Commission
C. Section 26 09 13.11 – Data Collection Controller

1.04 REFERENCES

A. Applicable codes, standards, and references codes, regulations and standards

1. NSF/ANSI Standard 61
2. NSF/ANSI Standard 372
3. AWWA C700 Standards
4. AWWA C701 Class 2 Standards
5. State and local codes and ordinances

1.05 COORDINATION

A. Coordinate Operations and Maintenance training times with the Owner.
B. Contractor shall provide a completed "Mechanical Meter Profile Report" form per Specification 23 08 00.11 Appendix A for each meter.

1.06 SUBMITTALS

A. General

1. Submittals shall be in accordance with Conditions of the Contract and Division 01 Specification Sections.
2. Submit detailed maintenance manuals and drawings, which include catalog information indicating the complete electrical and mechanical characteristics.
3. Submit dimensioned cross-sectional drawings (manufacturer's data sheets are acceptable).
4. Submit finished meter tests – Manufacturer's Certified Test Reports showing accuracy tests

1.07 OPERATIONS AND MAINTENANCE (O&M) MANUALS

A. Operations and Maintenance Manuals shall be in accordance with Conditions of the Contract and Division 01 Specification Sections.
B. Operations and Maintenance Manuals shall include catalog information indicating complete electrical and mechanical characteristics.
C. Manufacturer's Certified Test Reports
D. Manufacturer's drawings of meter wiring diagram.

1.08 MEETINGS

A. Pre-installation conference

1. The Contractor shall request a pre-installation conference with the UW Engineering Services

B. Attend meetings with the Owner and/or Owner's Representative as required to resolve any installation or functional problems.

PART 2 – PRODUCTS

2.01 GENERAL

A. These building meter specifications are in accord with the Owner's policy to construct permanent installations with long life, coupled with maximum reliability and safety.

2.03 UW WATER METER

A. The following shall apply to all UW water meters on the UW Campus:

1. UW water meter shall operate by electromagnetic induction principle.

    a. Meter shall measure flow using Faraday's law.
    b. Meter shall have a stable K-factor that is not influenced by external piping or mounting orientation.
    c. Meter shall have uniform magnetic field flux distribution piping straight run and flow profiling.
    d. Meter shall measure fluids with conductivity greater than or equal to 3.0 uS/cm2

e. Meter shall be capable achieving an accuracy of +/- 0.25% of the reading for liquids with a 1.5x pipe diameter from center of meter of straight pipe run up and downstream.
f. Meter shall be capable of achieving an accuracy of +/- 0.50% of the reading for liquids without any piping straight run.
g. Meter shall accept 120V AC power source.

2. UW water meter shall have the following rangeability:
   a. 300 to 1 turndown minimum at +/- 0.25% accuracy
   b. 400 to 1 turndown minimum at +/- 0.50% accuracy
   c. 500 to 1 turndown minimum at +/- 1.00% accuracy
3. UW water meter shall measure and report the following quantities at a minimum:
   a. Setup to record cubic feet.
4. Meter fluid temperature range
   a. 14°F to 248°F with integral electronics, PFA liner, and Hastelloy C electrodes
   b. 14°F to 356°F with remote electronics, PFA liner, and Hastelloy C electrodes
5. UW water meter shall have digital display and totalization for local monitoring
6. UW water meter shall have a minimum of 2 pulse and analog (4-20mA) outputs for remote monitoring
7. Meter electronics shall be housed in a NEMA 4X enclosure.
8. Meter shall be suitable for installations on pipes sizes from 0.5” to 48” diameters.
9. Meter shall be capable of measuring following flow:

Magmeter	Liquid Flow Range Table	
Body Size	Minimum Volumetric (gal/min) Range	Maximum Volumetric (gal/min) Range
0.5”	0.00-0.25	0.00-25.00
1”	0.00-0.75	0.00-75.00
1.5”	0.00-1.75	0.00-175.0
2”	0.00-3.00	0.00-300.0
3”	0.00-8.00	0.00-800.0
4”	0.00-12.50	0.00-1250.0
6”	0.00-25.00	0.00-2500.0
8”	0.00-50.00	0.00-5000.0
10”	0.00-75	0.00-7500.0

10. Meter Body

a. The meter will consist of a full bore body with encapsulated and rigidly retained set of coils.
b. The meter body shall be constructed of 316 stainless steel, and rated for a maximum allowable non-shock pressure and temperature for steel pipe flanges, according to ANSI B16.5.
c. The meter body end connections shall be carbon steel or 316 stainless steel flanged, according to ANSI B16, Class 150 and AWWA Class B standards.
d. The meter body shall be available in ANSI Class 150 or Class 300 ratings.

PART 3 – EXECUTION

3.01 REQUIREMENTS

A. Application

1. Main Building Water Meter

a. Provide a main UW water meter for each building served by the UW water service. Meter to communicate to UW Advanced Metering System.
b. SPU to provide main water meter for buildings served by SPU water service.

2. Water Submeters

a. Provide water submeters for each of the following sub-systems:

i. Reclaimed water (if provided at project's discretion),
ii. Rainwater harvest (if provided at project's discretion)
iii. Water subsystems where Facilities Services recharges self-sustaining departments
iv. Elsewhere as required to meet code or achieve rating system credits.

b. Water submeters to communicate to the Advanced Metering System.

3. Sewer Submeters

a. Provide water sub-meters in accordance with Specification 23 05 19.31 Sewer Submeter Purchase Spec for each of the following sub-systems:

i. Irrigation (Civil/Site)
ii. Irrigation (Mechanical/Building)
iii. Cooling Tower Makeup
iv. Cooling Tower Blowdown/Drain

4. Water Submeters Miscellaneous

a. Provide water sub-meters each of the following sub-systems:

i. Hydronic closed loop makeup water connections
ii. Elsewhere as necessary to function as part of Building Automation System.

b. Water submeter to communicate to the Building Automation System (BAS).

B. General installation

1. Identification

    a. Reference section 23 05 53 Identification of Mechanical Piping and Equipment

2. Installation

    a. Only personnel qualified and experienced in this type of work shall make connections.
    b. The installation of meters shall be done with care to avoid damage.

        i. Meters showing damage after installation shall be replaced.
        ii. Meters shall have adequate clearance to service, repairs, and replacement.
        iii. Data collection cabinets hung improperly shall be properly secured and all paint scratches shall be touched up.

    c. Provide adequate pipe diameters upstream and downstream of installed meter. See Manufacturer's recommendations.
    d. Each UW water meter shall have a dedicated twisted-pair shielded cable installed for each 24VDC digital pulse out to the data collection controller.
    e. Meters shall be installed such that the display can be easily read. A shield shall be supplied if display is in direct sunlight.
    f. UW water meters shall be provided with shutoff valves and a bypass connection to allow for continuous service during periods of meter maintenance.
    g. Provide appropriate installation kit based upon pipe material.
    h. Provide adequate slack in flexible communication conduit to allow for the removal of the deduct meter.

3. UW will check the Contractor's work to ensure the accuracy of the installation.

    a. The Contractor shall arrange with the Owner for the times when their services will be required, and under no circumstances shall the Contractor connect to the existing system without Owner's knowledge.
    b. The proper connection of the wires and cables to other systems as specified is entirely the responsibility of the Contractor.
    c. In the event the connections cannot be made as specified, the Contractor shall make the necessary corrections at his own expense.

4. Install meters per manufacturer's recommendations.
5. Meter shall be UL Listed from manufacturer or shall be field listed.

C. Mounting and electrical connections

1. In accordance with manufacturer's installation instructions.
2. Install a dedicated 120V circuit from power source to the Data Collection Controller to provide power to the UW water meter and sub-meters.
3. Install 24V circuits from the Data Collection Controller to the water meter and sub-meters.24V circuit shall be THWN or XHHW insulation and installed in a GRC/IMC conduit. A 'C' condulet is to be used when transitioning from conduit to device. Flexible

conduit shall be jacketed metallic “sealtite” style with enough slack to allow for the removal of the device.

D. Testing

1. Contractor to verify meter is reading accurately.
2. Contractor to submit meter accuracy report of verified meter reading.

E. Integration and Commissioning

1. See section 23 08 00.11 Mechanical Meter Integration and Commissioning

23 05 19.51 Gas Meter – Purchase Spec

PART 1 – GENERAL

1.01 DESCRIPTION

A. Purpose

1. This section covers gas meters and sub-meters for use in the Owner's systems.

1.02 QUALIFICATIONS

A. Approved manufacturers

1. UW Gas Main Meter for up to 1 1/2" C
   a. American Meter – AL-1000
   b. Or approved equal
2. UW Gas Main Meter for 2" or Larger
   a. American Meter
   b. Dresser Measurement
3. UW Gas Sub-Meter
   a. To be determined
4. Twisted-pair shielded cable
   a. Belden 88760
   b. Or Approved Equal
5. PSE Gas Meter
   a. Provided by PSE

1.03 RELATED SECTIONS

A. 01 91 00 – General Commission Requirements
B. 23 08 00.11 – Mechanical Meter Integration and Commissioning
C. 26 09 13.11 – Data Collection Controller

1.04 REFERENCES

A. Applicable codes, standards, and references codes, regulations and standards

1. ANSI B109.1 Diaphragm-Type Gas Displacement Meters (under 500 cubic feet per hour capacity)
2. ANSI B109.2 Diaphragm-Type Gas Displacement Meters (500 cubic feet per hour and over)
3. ANSI B109.3 Rotary-Type Gas Displacement Meters
4. UL 61010-1 Electrical Equipment for Measurement, Control and Laboratory Use

5. NEMA 4X/6P (IP66/IP67)
6. State and local codes and ordinances

1.05 COORDINATION

A. Coordinate Operations and Maintenance training times with the Owner.
B. Contractor shall provide a completed "Mechanical Meter Profile Report" form per Specification 23 08 00.11 Appendix A for each meter.

1.06 SUBMITTALS

A. General

1. Submittals shall be in accordance with Conditions of the Contract and Division 01 Specification Sections.
2. Submit detailed maintenance manuals and drawings, which include catalog information indicating the complete electrical and mechanical characteristics.
3. Submit dimensioned cross-sectional drawings (manufacturer's data sheets are acceptable).
4. Submit finished meter tests – Manufacturer's Certified Test Reports showing accuracy tests

1.07 OPERATIONS AND MAINTENANCE (O&M) MANUALS

A. Operations and Maintenance Manuals shall be in accordance with Conditions of the Contract and Division 01 Specification Sections.
B. Operations and Maintenance Manuals shall include catalog information indicating complete electrical and mechanical characteristics.
C. Manufacturer's Certified Test Reports
D. Manufacturer's drawings of meter wiring diagram.

1.08 MEETINGS

A. Pre-installation conference

1. The Contractor shall request a pre-installation conference with the UW Engineering Services for UW projects

B. Attend meetings with the Owner and/or Owner's Representative as required to resolve any installation or functional problems.

PART 2 - PRODUCTS

2.01 GENERAL

A. These gas meter specifications are in accord with the Owner's policy to construct permanent installations with long life, coupled with maximum reliability and safety.

2.02 GAS METER

A. The following shall apply to the UW gas meters installed on the UW Campus:

1. Gas meter shall use a hybrid analog/digital thermal mass flow sensing method.
2. Gas meter shall have the following accuracy for natural/propane gas:
    a. +/- 1.0% of reading from 500 to 7000 SFPM
    b. +/- 2.0% of reading from 100 to 500 SFPM
3. Gas meter shall be wet calibrated in a flow laboratory. A certificate of calibration shall accompany each meter.
4. Gas meter shall have an overall flow range of 5 to 35,000 SFPM.
5. Gas meter shall accommodate fluid temperature range of -40 to 200° F
6. Gas meter shall have digital display for local monitoring
7. Gas meter electronics shall be housed in a NEMA 4X enclosure. Meter electronics shall be mounted remotely when direct wiring is not feasible.
8. Gas meter shall be suitable ambient temperatures of 0 to 150° F.
9. Gas meter connections shall be as follows:
    a. Diaphragm style meters shall be threaded.
    b. Rotary meters shall have meter body flanges.
10. Gas meter shall accommodate a 120V AC source.
11. Gas meter shall be capable of operating at 60 PSIG MAOP, with the option for operating in pressures up to 100 PSIG MAOP.
12. Gas meter shall accommodate a delivery pressure of 10 inches of water column.
13. Gas meter shall have a maximum pressure drop of 0.5" w.c. in pipe sizes above 1-1/2" diameter, and less than 0.9" w.c. for pipe diameters of 1-1/2" and below.
14. Gas meter shall have a digital pulse output.
15. Gas meter shall be constructed of die cast aluminum, diaphragms shall be made of Buna-N rubber.

PART 3 – EXECUTION

3.01 REQUIREMENTS

A. General installation

1. Identification
    a. Reference section 23 05 53 Identification of Mechanical Piping and Equipment
2. Installation
    a. Only personnel qualified and experienced in this type of work shall make connections.
    b. The installation of meters shall be done with care to avoid damage.
        i. Meters showing damage after installation shall be replaced.

ii. Meters shall have adequate clearance to service, repairs, and replacement.

c. Provide adequate pipe diameters upstream and downstream of installed meter. See Manufacturer's recommendations.
d. Rotary meters shall have a filter installed before the intake of the meter.
e. Each gas meter shall have dedicated twisted shielded pair communication cable installed to connect the meter's digital pulse port to the Data Collection Controller.
f. Meters shall be installed such that the odometer can be easily read.
g. Provide appropriate installation kit based upon pipe material.
h. Provide adequate slack in flexible communication conduit to allow for the removal of the flow meter.

3. UW will check the Contractor's work to ensure the accuracy of the installation.

   a. The Contractor shall arrange with the Owner for the times when their services will be required, and under no circumstances shall the Contractor connect to the existing system without Owner's knowledge.
   b. The proper connection of the wires and cables to other systems as specified is entirely the responsibility of the Contractor.
   c. In the event the connections cannot be made as specified, the Contractor shall make the necessary corrections at his own expense.

4. Install meters per manufacturer's recommendations.
5. Meter shall be UL Listed from manufacture or shall be field listed.

B. Mounting and electrical connections

   1. In accordance with manufacturer's installation instructions.
   2. Install a dedicated 24V circuit from the Data Collection Controller to provide power to the meter.
   3. 24V circuit shall be THWN or XHHW insulation and installed in a rigid conduit to a junction box located next to the meter. A flexible conduit shall be connected from the junction box to the meter with enough slack to allow for removal of the meter.

C. Testing

   1. Contractor to verify meter is reading accurately.

D. Integration and Commissioning

   1. See section 23 08 00.11 Meter Integration and Commissioning

23 08 00.11 Mechanical Meter Integration and Commissioning

PART 1 – GENERAL

1.01 DESCRIPTION

A. Purpose

1. The purpose of this section is to specify Contractor responsibilities and participation in the mechanical meter integration and commissioning process.

B. General

1. Commissioning support is the responsibility of the Contractor (including subcontractors and vendors).

   a. The commissioning process requires Contractor participation to ensure all portions of the work have been completed in a satisfactory and fully operational manner. The Contractor is responsible to provide all support required for start-up, testing, and commissioning.

2. Work of this section includes the following:

   a. Start-up and testing of the equipment
   b. Assistance in testing, adjusting and balancing
   c. Operating equipment and systems as required for commissioning tests
   d. Provide Testing Plans to the Owner for review and approval prior to commissioning.
   e. Providing qualified personnel for participation in commissioning test, including seasonal testing required after the initial commissioning
   f. Providing equipment, materials, and labor necessary to correct deficiencies found during the commissioning process, which fulfill contract and warranty requirements
   g. Providing operation and maintenance information and as-built drawings to the Owner for verification.
   h. Providing training for the systems specified in this Division with the Owner’s Representative.

3. The project shall reimburse Facilities Services for cost of the owner’s System Integration contractor services.

1.02 RELATED SECTIONS

A. All start-up and testing procedures and documentation requirements specified within Division 23 and Division 33.

1.03 REFERENCES

A. Applicable codes, standards, and references All inspections and tests shall be in accordance with the following applicable codes and standards except as provided otherwise herein:

1. International Electrical Testing Association - NETA
2. National Electrical Manufacturer's Association - NEMA
3. American Society for Testing and Materials - ASTM
4. American Water Works Association - AWWA
5. American National Standards Institute - ANSI
6. National Electrical Safety Code - C2
7. State and local codes and ordinances
8. Occupational Safety and Health Administration - OSHA 29CFR Part 1910.269
9. National Fire Protection Association - NFPA

B. All inspections and tests shall utilize the following references:

1. Project design drawings and specifications
2. Shop drawings and submittals
3. Approved manufacturer's instruction manuals applicable to each particular apparatus
4. Applicable NETA acceptance testing work scope sections per NETA ATS 1999

1.04 COORDINATION

A. Coordinate the completion of all mechanical testing, inspection, and calibration prior to the start of commissioning activities.
B. Coordinate factory field-testing and assistance per the requirements of this section.
C. The Contractor shall coordinate and cooperate in the following manner:

1. Allow a minimum of 10 working days before final commissioning dates to complete mechanical testing, inspection, and calibration to avoid delays in the commissioning process.
2. During the commissioning activities, provide labor and material to make corrections when required, without undue delay.

1.05 UW NETWORK INTEGRATION

A. Owner’s System Integration (SI) contractor shall program the Owner’s aggregation software to read the installed mechanical metering equipment. Contractor shall coordinate this work with the Owner and Owner’s SI contractor to ensure all programming is complete prior to commissioning.

1.06 SUBMITTALS

A. General

1. Submittals shall be in accordance with all Contract Documents and Division 01 Specification Sections.
2. Contractor shall provide information required on form found in Appendix A and submit to Owner.

1.07 OPERATIONS AND MAINTENANCE (O&M) MANUALS

A. Operations and Maintenance Manuals shall be in accordance with Conditions of the Contract and Division 01 Specification Sections.

1.08 SCHEDULE

A. Complete and make fully functional all phases of electrical work pertinent to the Commissioning Tests, prior to the testing date.

1.09 MEETINGS

A. Attend Commissioning Meetings as required by the Owner.

PART 2 – PRODUCTS

2.01 TEST EQUIPMENT

A. Provide test equipment as necessary for start-up and commissioning of the mechanical equipment and systems.

2.02 TEST EQUIPMENT - PROPRIETARY

A. Proprietary test equipment required by the manufacturer, whether specified or not, shall be provided by the manufacturer of the equipment.

1. Manufacturer shall demonstrate its use, and assist the Contractor in the commissioning process.
2. Proprietary test equipment shall become the property of the Owner upon completion of commissioning.

B. Identify the proprietary test equipment required in the test procedure submittals and in a separate list of equipment to be included in the Operations and Maintenance Manuals.

PART 3 – EXECUTION

3.01 REQUIREMENTS

A. Work prior to commissioning:

1. Complete all phases of work so the system can be started, tested, adjusted, balanced, and otherwise commissioned.
    a. Contractor has primary start-up responsibilities with obligations to complete systems, including all sub-systems so they are fully functional.
    b. This includes the complete installation of all equipment, materials, conduit, wire, controls, etc., per the contract documents and related directives, clarifications, change orders, etc.
2. Complete all equipment programming prior to commissioning.
    a. Steam Condensate Meters, Steam Condensate Submeters, and Hot Water Submeters
        i. Meters shall be programmed by the Owner prior to connecting the meter to the Data Collection controller.

ii. Meter program parameters shall be approved by the Owner or the SI.

b. Central Cooling Water Meters

i. Meters shall be programmed by the owner prior to connecting the meter to the Data Collection Controller.
ii. Meter program parameters shall include at a minimum the following outputs: supply temperature, return temperature, gallons per minute (GPM), btu/hr, gallons and btu (dual mode). Meter programming parameters shall be approved by the Owner or the SI.

c. Sewer Submeter

i. Meter shall be programmed by the owner to meet Seattle Public Utilities (SPU) requirements.
ii. Meter programming parameters shall be approved by the Owner or the SI

d. UW Water Meter and Submeters

i. Meters shall be programmed by the owner prior to connecting the meter to the Data Collection controller.
ii. Meter program parameters shall be approved by the Owner or the SI.

e. UW Gas Meter and Submeters

i. Meter shall be programmed by the owner prior to connecting the meter to the Data Collection Controller.
ii. Meter programming parameters shall be approved by the Owner or the SI

f. Data Collection Controller

i. Data Collection Controller shall be programmed by the Owner or SI prior to connecting to the Owner's facility network.
ii. Data Collection Controller program parameters shall be approved by the Owner or the SI.
iii. Data Collection Controller shall be connected to all applicable meters and all wiring shall be approved before being connected to the Owner's facility network.

g. Aggregation Software

i. Aggregation software shall be programmed by the SI
ii. Aggregation software shall have new screens created by the SI.
iii. The SI shall ensure each meter is being read by the aggregation software.

3. A commissioning plan will be developed by the Owner's Representative and approved by the Owner.

a. Minimum requirements for the commissioning plan shall include the following:

i. Verify meter part number
ii. Review of the mechanical meter's programming parameters:

(a) Verify flow rates
(b) Verify temperature readings
(c) Verify wiring configuration
(d) Verify display screens are in accordance with Owner's requirements

iii. Verify meter readings

(a) Contractor shall provide personnel support the verification of meter readings

iv. Verify Data Collection Controller part number
v. Verify all meters are properly connected to the Data Collection Controller
vi. Verify all meters are properly connected to the facility network
vii. Verify communication signals from the meters

(a) 4-20 mA communication shall be tested by the test personnel sending a test 4 – 20 mA signal from the transmitter through the receiving device to verify correct wire terminations, and engineering scaling units. A Loop Check testing procedure shall be used and all testing results shall be documented.
(b) Modbus TCP/IP communication shall be tested by the test personnel at the server room of the aggregation software.

viii. Verify communication between Data Collection Controller and the facility network.

(a) Verify data collection controller's IP address

ix. Verify all meters are being read by the Owner's aggregation software
x. Verify new screens are created in the aggregation software for the new meters

b. Standards used in instrument testing must be traceable to the International System of Units (SI) 5. The SI is used by the International Bureau of Weights and Measures (BIPM) to ensure worldwide unification of measurements. The traceability of the standards are maintained by an unbroken chain of calibrations or comparisons linking them to the relevant SI unit of measurement. The test equipment shall display the calibration date, and the calibration due date.
c. Calibration/test personnel should be trained, qualified, field-experienced metrologists or technicians well-versed in the practices, considerations, and terminology of the user's industry.
d. If system modifications/clarifications are in the contractual requirements of this and related sections of work, they will be made at no additional cost to the Owner.
e. If Contractor-initiated system changes have been made that alter the commissioning process, the Contractor will notify the Owner's Representative for approval.

4. The Contractor shall be responsible for the installation of all equipment prior to commissioning the system. The Contractor shall ensure at a minimum that the following equipment is installed:

a. Mechanical meters

b. Data Collection Controller
c. Communication cable
d. Power cables

5. Normal start-up services required to bring each system into a fully operational state:
   a. These include cleaning, testing, control sequences of operation, full and part load performance, etc.
   b. The Contractor will not begin the commissioning process until each system is complete
6. Commissioning is intended to begin upon completion of a system.
   a. Commissioning may proceed prior to the completion of systems, or sub-systems, and will be coordinated with the General Contractor and Testing Contractor.
   b. Contractor shall coordinate with the SI to provide programming and configuration prior to commissioning.
   c. Start of commissioning before system completion will not relieve Contractor from completing those systems as per the schedule.

3.02 PARTICIPATION IN COMMISSIONING

A. Provide skilled technicians to start up all systems within Division 23 and Division 33.
   1. Contractor will ensure that the qualified technician(s) are available and present during the agreed upon schedules and for sufficient duration to complete the necessary tests, adjustment, and/or problem resolutions.

B. System problems and discrepancies may require additional Contractor time, redesign and/or reconstruction of systems and system components. The additional Contractor time shall be made available for the subsequent commissioning periods until the required system performance is obtained.

C. The Owner's Representative reserves the right to judge the appropriateness and qualifications of the Contractor’s technicians relative to each item of equipment or system. Qualifications of Contractor’s technicians include expert knowledge relative to the specific equipment involved, adequate documentation and tools to service/commission the equipment, and an attitude/willingness to get the job done in a timely manner.

D. Contractor shall remove and replace covers of electrical equipment, open access panels, etc., to permit Owner’s Representative to observe equipment and controllers provided.

E. Furnish ladders, flashlights, tools and equipment as necessary.

3.03 WORK TO RESOLVE DEFICIENCIES

A. In some systems, misadjustments, misapplied equipment and/or deficient performance under varying loads will result in additional work being required to commission the systems.
   1. This work will be completed under the direction of the Owner's Representative, with input from the Contractor and equipment supplier.

2. Whereas all members will have input and the opportunity to discuss the work and resolve problems, the Owner's Representative will have final jurisdiction over the work necessary to achieve performance.

B. Corrective work shall be completed in a timely fashion to permit timely completion of the commissioning process.

1. Experimentation to render system performance will be permitted.
2. If the Owner's Representative deems the experimentation work to be ineffective or untimely as it relates to the commissioning process, the Contractor shall schedule a meeting with the Owner to discuss the nature of the problem, expected steps to be taken, and the deadline for completion of activities.
3. If deadlines pass without resolution of the problem, the Owner reserves the right to obtain supplementary services and/or equipment to resolve the problem.
4. Any costs incurred to solve the problems in an expeditious manner shall be the Contractor's responsibility.

3.04 SYSTEMS DOCUMENTATION

A. In addition to the requirements of Division 1, update contract documents to incorporate field changes and revisions to system designs to account for actual constructed configurations.

1. All drawings shall be red-lined on two sets.
2. Contractor as-built drawings shall include architectural floor plans, elevations and details, and the individual electrical systems in relation to actual building layout. Dimensions from a wall or permanent structure shall be shown for any equipment, conduit, cable, etc. installed in a different location than identified in the Contract documents.

B. Maintain as-built red-lines as required by Division 1.

1. Red-lining of drawings at completion of construction, based on memory of key personnel, is not satisfactory.
2. Continuous and regular red-lining is considered essential and mandatory.

Mechanical Meter Profile Report

Model:	
ID Number:	
Name:	
NVRAM:	

Firmware Versions

FirmWare	Boot	Runtime	Xilinx
Comm			
DSP			

Communication Settings

Item	Port 1	Optical	Port 4
Address			
Baud Rate			
Data Bits			
Parity			
Stop Bits 1			
Tx Delay			
Protocol			
Mode			

Time Setup

Time Zone:	
DST Enabled:	
DST Start:	
DST End:	
Line Sync:	
Frequency:	

Demand Setup **Block Window Sync**

Thermal Averaging Window:		Use Sync Pulse:	

Block Averaging Window:		High Speed Input #:				
Rolling Averaging Sub-Interval Window:		Generate End of Interval Pulse:				
Rolling Sub-Intervals:		Relay #:				
Predictive Rolling Window Average:		Pulse Width (ms):				

Trending Log 1 Interval

Hours	Minutes	Seconds

Trending Log 2 Interval

Hours	Minutes	Seconds

Network Settings

IP Address	
Subnet Mask	
Default Gateway	
Gateway Port Baud Rate	
Gateway Port Delay	
MAC Address (IEEE Registered)	

DNS Servers

DNS Server 1	
DNS Server 2	

Services

Modbus TCP Server	
Modbus TCP Client	

BACnet IP Server	
BACnet IP Client	
Web Server	
SMTP Server	
SMTP Client	
FTP Server	
FTP Client	
HTTP/Modbus RTU Server	

Alarm/Email

Email Server IP Address/Name	
Email Server Port	
Email Monitor Address	
Return/Reply Address	
Email Subject Text	
Email Server Requires Authentication	
Username	
Password	

FTP Client

FTP Server IP Address/Name	
FTP Server Port	
Startup Remote Directory	
Username	
Password	

Network Card Firmware Update Via Network

Enabled	
Server Port	
Server IP Address	
Client IP Address	
Subnet Mask	
Default Gateway	
Download Filename	

DNP LAN/WAN Settings

Mode:	

Connection:

DNP over TCP:		Listen on Port:			
DNP over UDP:		Listen on Port:			
Respond to:					

A	

Electrical

Seattle Centralized Systems

A. General Requirements

Basis of Design

This section applies to the general electrical requirements for all electrical work.

1. The majority of University construction is for permanent installation. Design electrical systems for a minimum anticipated 30 to 40-year life span before requiring major repairs or replacements. Exceptions to this requirement shall be discussed and agreed upon with Engineering Services during the programming phase. Such agreed upon exceptions shall be clearly stated in the Technical Program.
2. Facility design standards can vary for branch campus and off-site facilities. Review these projects with Engineering Services to determine modifications to the Facilities Services Design Standard as appropriate. State these approved modifications in the Technical Program.
3. It is the intent of the University of Washington to minimize construction cost by fostering competitive bidding. If the designer feels that one or more of the provisions of this design standard arbitrarily eliminate an otherwise qualified manufacturer from bidding the project, suggest and review changes to the appropriate sections with Engineering Services. This may result in a one-time change or in a permanent revision to the design standard.
4. Where a detailed analysis of the program reveals an inadequate budget to provide the appropriate system design, notify the Project Manager and Engineering Services, in writing, of the budget deficiency, the recommended system and its cost, and the alternatives if a budget revision is not provided.
5. The impact of long equipment delivery time and the advantages of obtaining a locally manufactured product shall be factored into the project cost estimate and schedule.
6. The location of equipment that produces noise, vibrations and exhaust and the use of products or processes that create hazardous or offensive noise or fumes may be restricted.
7. Coordinate with Engineering Services the design of special systems (unique shielded rooms, research and diagnostic equipment, and other equipment and designs not specifically covered by the design standard.)

Inter-discipline Coordination

1. The Electrical Engineer shall work closely with other design team members to coordinate the design and to ensure that the space planning adequately accommodates the building electrical infrastructure. The electrical, mechanical and structural space requirements will necessitate changes to the floor plans, building sections and exterior elevations, if not properly taken into consideration from the onset of design.

2. Intersystem connection and wiring requirements need to be carefully coordinated between the various disciplines. Special attention needs to be given to the various life safety system components.
3. Coordinate with the Architect on the waterproofing of the main electrical rooms.
4. Coordinate with Structural Engineer for the design of reinforced concrete housekeeping pad. Secure to structural slab.
5. Coordinate with Civil Engineer so that exterior raceways and exterior vaults do not drain into a building.

Reference Plans and Specifications

1. Extensive operational drawings of the primary electrical system, fire alarm, clock and bell systems are available. Unlike other record drawings, these drawings are not available from the Records Vault since they are being updated on a continuing basis by Campus Operations. The latest version of these drawings can be obtained from Engineering Services.
2. Several design specifications with specific language about the University requirements are included in the design standard. Spare parts inventories, prior experiences of the University, and staff training on the operation and maintenance of sophisticated equipment may restrict the list of suppliers to three or less, even though more suppliers with similar equipment may exist. Consultant’s standard practices on approved manufacturers, suppliers, systems and equipment may not be appropriate for use on University projects.

Operational Constraints

1. In remodel and renovation projects and for taps into existing feeders, shutdown of feeders and services may be necessary. These shutdowns may have to occur after normal working hours to prevent interruption of critical operations. All shutdowns must be carefully coordinated with the University and can take several weeks of planning so all affected departments can plan operations around the outage. Temporary power may be necessary to maintain service to critical loads in hospital, health care and laboratory areas and to refrigeration equipment. Delays in the construction schedule due to outage coordination shall be accounted for in the construction estimate and noted in specifications or drawings.
2. General use buildings are operated to match occupancy and are normally shut down during nights (10pm to 6am), weekends and holidays. Libraries usually have extended schedules. Health Science and laboratory buildings usually run continuously to maintain a safe working environment.

Construction Power

The point of service for construction power can be limited, especially where bulk power is required. The Engineer shall determine the construction power requirements and work with Engineering Services to identify the anticipated point of service. The Consultant shall specify that the Contractor provide and maintain an electrical construction power system for all needs, including power for the construction trailers. The Contractor shall provide metering for all construction power tap points. The Contractor shall be responsible for the connection to and removal of their equipment from the University’s system.

Renovation and Demolition

1. Renovation projects must include the evaluation of the existing systems including variances from current codes, system deficiencies, space limitations and available spare capacity. All design team disciplines shall participate in this evaluation jointly to develop innovative remodel concepts and solutions.
2. In general, remove abandoned equipment, raceways and conductors. Electrical design shall address correction of existing electrical problems and removing abandoned equipment, while maintaining the operation of the building. Define the reuse of equipment where appropriate.
3. Identify the cost and scope for the removal, remediation and disposal of hazardous materials (PCB ballasts, PCB transformers, PCB floor contamination, lead containing materials, asbestos, etc.)

B. Design Criteria

Programming

Provide equipment access pathways large enough to allow for the removal of transformers and other large pieces of equipment. Identify these areas on the design drawings.

Include an evaluation for building system renovation projects which describes the condition of the building systems, variances from present codes, and identifies spare system capacity or system deficiencies and opportunities for improving energy efficiency. The design team's mechanical, electrical, civil, structural, and architectural disciplines participate jointly in this evaluation.

Design Criteria

1. Provide the basis of design including design parameters and analyses for the following:
    a. Connection to existing utility distribution systems, including capacity and location
    b. Temporary construction service
    c. Distribution concepts
    d. Load calculations for campus utilities
    e. Seismic bracing for electrical equipment
    f. Special systems design (research and diagnostic equipment, and other equipment and designs not specifically covered by the FDS)
    g. Control systems and equipment monitoring
    h. Occupancy, hours, and degree of activity
    i. Internal loads
    j. Special loads
    k. Code requirements and impact on criteria
    l. Noise criteria
    m. Building energy consumption and energy source
    n. Life cycle cost analysis for electrical systems
    o. Sustainability
    p. Maintainability
    q. Redundancy
    r. Future Capacity
    s. Standby Power
    t. Fire and Life Safety
    u. Review liquid infiltration issues for: exterior site penetrations; floor finishes above main electrical rooms and risers
2. Design systems and components with maximum reliability, maximum flexibility, and minimum operation and maintenance cost. Give full consideration for future system alterations with a minimum of system shutdowns. Accomplish preventive maintenance without a major building shutdown. Maintenance accessibility is very important. Meet current regulations for worker safety, including fall protection.

3. Since laboratory buildings need periodic renovation to keep up with changing technology, divide the building up into lab modules.
4. Coordinate electrical equipment located on the roof with the Architect. Minimize the number of roof penetrations.
5. Provide an acceptable means of accessing major equipment that needs to be maintained on a regular basis without the use of a portable ladder.
6. Provide access platform for shafts.
7. Mount main service equipment (e.g. transformer, free standing switchboards) on a concrete pad secured to structural slab. Size concrete pads larger than equipment. Coordinate with Structural Engineer for final design.
8. See Architectural Finishes section for coating of floors above electrical rooms.
9. Coordinate with architectural and structural for location and installation.

Inter-discipline Coordination

1. Coordinate the electrical work with other disciplines to define the work and responsibilities of the Electrical Contractor. Because of the space taken up by the mechanical equipment coordinate the required infrastructure with all elements of the building to include architectural, structural and mechanical. In many cases, the mechanical and electrical system space requirements necessitate changes to the floor plans, building sections, and exterior elevations, if not properly coordinated at the onset.
2. Align electrical risers to minimize offsets.
3. Coordinate between the Mechanical Engineer and Electrical Engineer for equipment motors, motor starters, disconnect switches, thermal overload switches, variable frequency drives, mechanical controls and grounding for all mechanical equipment including AHUs, exhaust fans, and pumps.

Operational Constraints

1. Sustainability, operability, and maintainability are key elements in the evaluation of the Technical Program and Schematic Design. General use buildings are operated to match occupancy and are normally shut down during nights (10pm to 6am), weekends and holidays. Libraries usually have extended schedules. Laboratory buildings normally run continuously to maintain a safe working environment 24 hours per day. Evaluate on a building-by-building basis; to allow a more efficient operation.
2. In remodel or renovation projects, shutdowns of existing utilities and services may be necessary. These shutdowns may have to occur after normal working hours to prevent interruption of critical operations. Temporary utilities may be necessary to maintain service to critical loads in laboratories and hospital health care areas and to refrigeration equipment.
3. Locate equipment and accessories above ceilings such that they can be readily accessed within arm's reach by a person standing no higher than the second highest step on a stepladder of a height that fits below the ceiling. Coordinate ladder placement to avoid interference from casework, lab benches, sinks, adjacent walls, or lab equipment. Give consideration to ceiling tiles immovable due to sprinkler heads, light fixtures, or other ceiling mounted devices.

Construction Requirements

1. Include a statement in the specifications that all components of the electrical system must be kept clean and dry as manufactured, delivered, stored and installed before energization.

Renovation and Demolition

1. The abandonment of existing equipment and material in place is not acceptable. Conserve space as much as possible.
2. The correction of existing electrical problems and removal of abandoned equipment, while maintaining the operation of the building, all need to be addressed in the contract documents.

C. Primary Distribution

Basis of Design

This section applies to the design relating to connections to the Seattle campus primary electrical distribution systems.

Background Information

1. The power system serving the Seattle campus is owned and operated by the University. The University effectively runs its own electrical utility. The systems are operated and maintained by the Campus Operations High Voltage Electric Shop.
2. The University's normal power primary distribution is a 13.8 kV, 3-phase, 3-wire, low resistance grounded wye system. All new services will be connected to this system.
3. The University has a campus emergency and standby power system. Refer to the Electrical - Emergency Systems section for detailed information.
4. The University receives power from Seattle City Light (SCL) at two locations on campus. The utility **"*points of service*"** are located at the secondary connection to the SCL transformers. Four SCL feeders and transformers serve the University's West Receiving Station at 15th NE and Pacific St. One SCL feeder and transformer serves the University's East Receiving Station at the Power Plant. Interties connect the two stations and are switched to regulate power flow as required. A 6MW-extraction steam turbine in the Power Plant provides some co-generation. The amount varies with the campus steam load.
5. Normal and emergency power is distributed from the receiving stations through tunnels, utilidors and ductbanks. 500kcm metal-clad, interlocked armored cables feed power throughout the campus. #2/0 metal-clad, interlocked armored cable taps in manholes extend service into the buildings and padmount equipment. Relays at the receiving stations provide fault and overload protection for the 500kcm cable systems but only fault protection for the #2/0 cables. Fuses at the building disconnect switches provide overload protection for these #2/0 cables.
6. Equipment and conductors from the **"*points of service*"** to individual building secondary main breakers are designated as **"*service conductors*"** and include primary fused disconnect switches, service transformers, and secondary conductors to the secondary main breakers.
7. The building transformer secondary main breaker shall be designated as **"*service disconnect*"** and **"*service overcurrent protection*"**.
8. The Consultant shall coordinate all field design investigative work around the medium voltage systems and equipment with the High Electric Shop Lead or Supervisor. Field visits may require that a high voltage worker accompanying the Engineer.

Design Criteria

1. Medium voltage cable systems are standardized at 500kcm and #2/0. Code sized conductors can be used downstream of fused load interrupter switches and motor starters. Provide a minimum #2 ground conductor (regardless of the size of the phase conductors),

galvanized steel interlocked armor, and a PVC outer jacket to form a complete assembly. The ground conductor size is based on the 500kCM feeder size and the relays being set to protect 500kCM cables for fault protection. **Note that this is a non-standard ground wire size for 2/0 cable assemblies.** The Authority Having Jurisdiction (AHJ) may allow for a separate ground conductor to run parallel and external to the cable assembly so that industry standard cable can be specified. AHJ approval would be required.

2. For typical Utility Tunnel details, refer to the following Standard Drawings in the "Utility Tunnels and Trenches" Section 2T.
   a. Drawing-Utility Tunnel Section
   b. Drawing-Utility Trench Section
   c. Drawing-Utility Tunnel Manhole Plan
   d. Drawing – Utility Tunnel Electrical Tray Bracket Detail
3. Service conductor ductbanks shall be concrete encased and provided with spare cells for future services or cable replacements. Consider ductbank conductor derating per NEC be when sizing the conductors and raceways. For these purposes, conductors larger than the University standard sizes may be required. For example, where 500kcm feeders need to be routed through a ductbank to reach their destination, they may have to be sized to 750kcm in order to retain the power delivery capacity of the feeder.
4. The use of padmount equipment is limited to locations where aesthetics allow. A buried vault to hold the transformer and associated equipment may be required. Generally, locate equipment within building electrical vaults or rooms.
5. Cables are generally subject to ambient temperatures of –20º to +40º C (0 to 105º F).
6. Conduits for medium voltage installations are rigid steel in buildings and street crossings; for direct buried or concrete encased applications, schedule 80 PVC may be used. Medium voltage cable shall not be directly buried.
7. Conduits for primary medium voltage distribution trunks (500 kcm cable) shall be 5" diameter minimum. Larger conduit may be required to facilitate cable pulls for long runs and multiple bends. Conduits for MV cable downstream of load interrupter switches and MV motor starters (#2/0 cable) shall be sized per code and cable pulling requirements.
8. Bends for 5" conduit used for primary medium voltage distribution trunks (500 kcm cable) shall have 5' radius minimum, to facilitate cable pulling operations. Radii for bends of smaller diameter conduit for MV cable downstream of load interrupter switches and MV motor starters (#2/0 cable) shall be per code and cable pulling requirements.
9. Termination and pulling vaults for medium voltage distribution shall be 7'Dx10'Wx10'L minimum to allow installation of MV load break elbows for taps to future facilities. Installation of smaller vaults shall not be allowed unless coordinated and approved in writing by UW Engineering Services.
10. Grounding systems shall be provided for all primary distribution ductbanks, utility tunnels, manholes, pulling vaults, transformer pads, switch pads, etc.
11. For future projects in the utility tunnels an exposed and accessible personnel safety ground conductor shall be installed along tunnel lengths. Personnel safety ground conductor shall be 5000 kcm minimum and shall be installed such that they are readily accessible anywhere in the tunnel.

Submittals

1. Provide standard industry submittal requirements. In addition, comply with requirements specified in related sections.

Products, Materials and Equipment

1. Refer to the requirements specified in individual Electrical sections.

Installation, Fabrication and Construction

1. Cable and wire procurement, especially for short lengths of interlock armored cable, can take additional time. The Consultant shall include fair warning to the Contractor in the specifications.
2. Cable trays are used in tunnels, manholes, and elsewhere for carrying utility cables. For service reliability and safety, place only one high voltage cable in any individual cable tray unless otherwise directed. Cable trays, in general, shall be sized 9 inches wide in tunnels and 12 inches wide in manholes and shall include fire-resistant tray liners. Tray liners shall be non-asbestos type and shall be marked as such. Apply fireproof tape to cables installed outside of the cable trays.
3. In special cases, with prior written approval by UW Engineering Services, two cables may be routed in one cable tray. In such case, provide a tray-dividing barrier. The barrier shall be at least as tall as the armored cable diameter and securely fastened to the tray.
4. Do not use cable link boxes for new medium voltage splices, connections, and taps. (Cable link boxes are being phased out from the primary distribution system). Utilize cable junction boxes.
5. Medium voltage cable splices and connections are often placed in tunnels and manholes open to non-electrical workers. This requires that splices have protective covers and junction boxes have protective cages. The Consultant shall investigate and work with Engineering Services in designing appropriate worker protection barriers.
6. Size junction boxes and electrical vaults for terminations to allow future expansion of the cable system.
7. Splices may be placed in cable tray or supported on structure walls.

D. Electrical Meter and SCADA System

Basis of Design

This section applies to the requirements both the Design Engineer and the Contractor.

Background Information

The Seattle campus collects metering and Supervisory Control and Data Acquisition System (SCADA) information

Design Criteria

Consultant needs to:

1. Review work scope with Engineering Services and Campus Utilities & Operations so a draft connection diagram can be submitted.
2. Work with a potential equipment suppliers to verify how data will be posted on the UW VPN.
3. Reserve fees for UW Designated System Integrator

Construction Submittals

Coordinate with all the trades and disciplines involved. At minimum: fields installers of metering equipment, MV switches, transformers, transfer switches.

Products, Materials and Equipment

Refer to the following standard specifications.

Installation, Fabrication and Construction

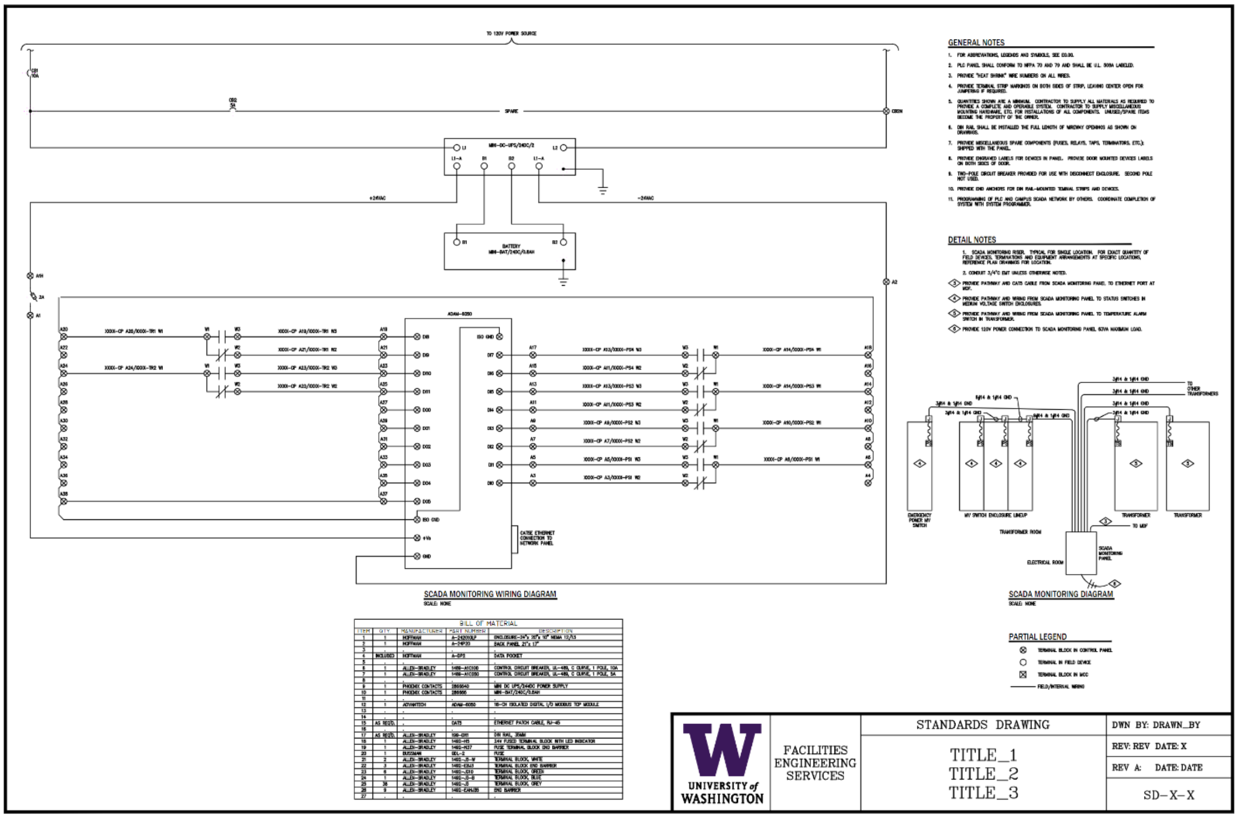
REQUIREMENTS:

1. General installation
    a. Identification
        i. Reference section 26 05 53 Identification
    b. Installation
        i. Only personnel qualified and experienced in this type of work shall make connections.
        ii. The installation of meters shall be done with care to avoid damage.
            (a) Meters showing damage after installation shall be replaced.
            (b) Metering cabinets hung improperly shall be properly secured and all paint scratches shall be touched up.
        iii. Each meter shall have dedicated CAT5E communication cable installed to connect the meter to the facility network.

iv. Meters shall be installed such that the display is no higher than 72” above the floor.

c. System Phase Sequence is C-B-A.
d. Campus Utilities & Operations and Systems Integrator will check the Contractor's work to ensure the accuracy of the connections.
    i. The Contractor to arrange with the Owner for the times when their services will be required, and under no circumstances shall the Contractor connect to the existing system without Owner’s knowledge.
    ii. The proper connection of the wires and cables to other systems as specified is entirely the responsibility of the Contractor.
    iii. In the event the connections cannot be made as specified, the Contractor shall make the necessary corrections at his own expense.
e. Install meters and SCADA i/o per manufacturer's recommendations.

2. Mounting and electrical connections
    a. In accordance with manufacturer's installation instructions.
    b. Install a dedicated 120V circuit from panelboard to provide power to the electrical meter in a dedicated RGC/IMC. (if required)
3. UL Listing
    a. The Contractor shall ensure that the metering and SCADA installations are UL Listed.
4. SCADA Integration


GENERAL NOTES
DETAIL NOTES
SCADA MONITORING WIRING DIAGRAM
SCADA MONITORING DIAGRAM
PARTIAL LEGEND
BILL OF MATERIAL
UNIVERSITY of WASHINGTON
FACILITIES ENGINEERING SERVICES
STANDARDS DRAWING
TITLE_1
TITLE_2
TITLE_3
DWN BY: DRAWN_BY
REV: REV DATE: X
REV A: DATE: DATE
SD-X-X

ELECTRICAL METER AND SCADA INTEGRATION AND COMMISSIONING – STANDARD SPECS

STANDARD SPECIFICATIONS

This standard specification is intended to be integrated into the project specifications. The Consultant shall write the specifications to meet the project needs in consultation with the Owner and in accordance with the attached design information section.

PART 1 – GENERAL

1.01 DESCRIPTION

A. Purpose

1. The purpose of this section is to specify Contractor responsibilities and participation in the electrical meter integration and commissioning process.

B. General

1. Commissioning support is the responsibility of the Contractor (including subcontractors and vendors).
    a. The commissioning process requires Contractor participation to ensure all portions of the work have been completed in a satisfactory and fully operational manner. The Contractor is responsible to provide all support required for start-up, testing, and commissioning.
2. Work of this section includes the following:
    a. Start-up and testing of the equipment
    b. Assistance in testing, adjusting and balancing
    c. Operating equipment and systems as required for commissioning tests
    d. Provide Testing Plans to the Owner for review and approval prior to commissioning.
    e. Providing qualified personnel for participation in commissioning test, including seasonal testing required after the initial commissioning
    f. Providing equipment, materials, and labor necessary to correct deficiencies found during the commissioning process, which fulfill contract and warranty requirements
    g. Providing operation and maintenance information and as-built drawings to the Owner for verification.
    h. Providing training for the systems specified in this Division with the Owner's Representative.

1.02 RELATED SECTIONS

A. All start-up and testing procedures and documentation requirements specified within Division 26.

1.03 REFERENCES

A. Applicable codes, standards, and references - All inspections and tests shall be in accordance with the following applicable codes and standards except as provided otherwise herein:

1. International Electrical Testing Association - NETA
2. National Electrical Manufacturer's Association - NEMA
3. American Society for Testing and Materials - ASTM
4. Institute of Electrical and Electronic Engineers - IEEE
5. American National Standards Institute - ANSI
6. National Electrical Safety Code - C2
7. State and local codes and ordinances
8. Insulated Power Cable Engineers Association - IPCEA
9. Association of Edison Illuminating Companies - AEIC
10. Occupational Safety and Health Administration - OSHA 29CFR Part 1910.269
11. National Fire Protection Association - NFPA
    a. ANSI/NFPA 70: National Electrical Code
    b. ANSI/NFPA 70B: Electrical Equipment Maintenance
    c. NFPA 70E: Electrical Safety Requirements for Employee Workplaces
    d. ANSI/NFPA 78: Lightning Protection Code
    e. ANSI/NFPA 101: Life Safety Code
    f. NFPA 99: Health Care Facilities

B. All inspections and tests shall utilize the following references:

1. Project design drawings and specifications
2. Shop drawings and submittals
3. Approved manufacturer's instruction manuals applicable to each particular apparatus
4. Applicable NETA acceptance testing work scope sections per NETA ATS 1999

1.04 COORDINATION

A. Coordinate the completion of all electrical testing, inspection, and calibration prior to the start of commissioning activities.

B. Coordinate factory field-testing and assistance per the requirements of this section.

C. The Contractor to coordinate and cooperate in the following manner:

1. Allow a minimum of 10 working days before final commissioning dates to complete electrical testing, inspection, and calibration to avoid delays in the commissioning process.
2. During the commissioning activities, provide labor and material to make corrections when required, without undue delay.

1.05 UW NETWORK INTEGRATION

A. Owner's System Integrator (SI) contractor will program the Owner's aggregation software to read the installed electrical metering and SCADA equipment. Contractor to coordinate this work with the Owner and Owner's SI contractor to ensure all programming is complete prior to commissioning.

1.06 SUBMITTALS

A. General

1. Submitted in accordance with all Contract Documents and Division 01 Specification Sections.
2. Contractor to provide information required on form in Appendix A and submit to Owner.

1.07 OPERATIONS AND MAINTENANCE (O&M) MANUALS

A. Operations and Maintenance Manuals to be in accordance with Conditions of the Contract and Division 01 Specification Sections.

1.08 SCHEDULE

A. Complete and make fully functional all phases of electrical work pertinent to the Commissioning Tests, prior to the testing date.

1.09 MEETINGS

A. Attend Commissioning Meetings as required by the Owner.

PART 2 – PRODUCTS

2.01 TEST EQUIPMENT

A. Provide test equipment as necessary for start-up and commissioning of the electrical equipment and systems.

2.02 TEST EQUIPMENT - PROPRIETARY

A. Proprietary test equipment required by the manufacturer, to be provided by the manufacturer of the equipment.

1. Manufacturer to demonstrate its use, and assist the Contractor in the commissioning process.
2. Proprietary test equipment shall become the property of the Owner upon completion of commissioning.

B. Identify the proprietary test equipment required in the test procedure submittals and in a separate list of equipment to be included in the Operations and Maintenance Manuals.

PART 3 – EXECUTION

3.01 REQUIREMENTS

A. Work prior to commissioning:

1. Complete all phases of work so the system can be started, tested, adjusted, balanced, and otherwise commissioned.
    a. Contractor has primary start-up responsibilities with obligations to complete systems, including all sub-systems so they are fully functional.
    b. This includes the complete installation of all equipment, materials, conduit, wire, controls, labeling etc., per the contract documents and related directives, clarifications, change orders, etc.
2. Complete all equipment programming prior to commissioning.
    a. Electrical Meters
        i. Meters shall be programmed prior to connecting the meter to the facility network.
        ii. Meter program parameters shall be approved by the Owner or the System Integrator.
        iii. All wiring shall be approved before being connected to the Owner's facility network.
    b. Aggregation Software
        i. Aggregation software to be programmed by the SI.
        ii. Aggregation software program parameters shall be approved by the Owner.
3. A commissioning plan will be developed by the Owner's Representative and approved by the Owner.
    a. Minimum requirements for the commissioning plan shall include the following:
        i. Verify meter part number
        ii. Review of the electrical meter's programming parameters:
            (a) Verify CT and PT ratios
            (b) Verify wiring configuration
            (c) Verify display screens are in accordance with Owner's requirements
        iii. Verify meter readings
            (a) Contractor shall provide personnel support and a calibrated digital multimeter for verification of meter readings
        iv. Verify electrical equipment is properly connected to the facility network.
        v. Verify communication between the electrical equipment and the facility network at the facility network server.
        vi. Verify all electrical equipment are being read by the Owner's Aggregation software

vii. Verify new screens are created in the aggregation software for the new electrical meters.

viii. Verify Owner's aggregation software power readings

(a) Contractor to provide personnel support and a calibrated digital multimeter for verification of meter readings

b. If system modifications/clarifications are in the contractual requirements of this and related sections of work, they will be made at no additional cost to the Owner.

c. If Contractor-initiated system changes have been made that alter the commissioning process, the Contractor will notify the Owner's Representative for approval.

4. The Contractor is responsible for the installation of all equipment prior to commissioning the system. The Contractor verifies at a minimum that the following equipment is installed:

   a. Electrical meters (includes automatic transfer switches)
   b. Communication cable
   c. SCADA equipment (includes automatic transfer switches).

5. Normal start-up services required to bring each system into a fully operational state:

   a. These include cleaning, testing, phase rotation check, control sequences of operation, full and part load performance, etc.
   b. The Contractor will not begin the commissioning process until each system is complete

6. Commissioning is intended to begin upon completion of a system.

   a. Commissioning may proceed prior to the completion of systems, or sub-systems, and will be coordinated with the Electrical Contractor and Electrical Testing Contractor.
   b. Contractor shall coordinate with the SI to provide programming and configuration prior to commissioning.
   c. Start of commissioning before system completion will not relieve Contractor from completing those systems as per the schedule.

3.02 PARTICIPATION IN COMMISSIONING

A. Provide skilled technicians to start up all systems within Division 26.

   1. Contractor will ensure that the qualified technician(s) are available and present during the agreed upon schedules and for sufficient duration to complete the necessary tests, adjustment, and/or problem resolutions.

B. System problems and discrepancies may require additional Contractor time, redesign and/or reconstruction of systems and system components.

C. The Owner's Representative reserves the right to judge the appropriateness and qualifications of the Contractor's technicians relative to each item of equipment or system. Qualifications of Contractor's technicians include expert knowledge relative to the specific equipment involved, adequate documentation and tools to service/commission the equipment, and an attitude/willingness to get the job done in a timely manner.

D. Contractor is responsible for the removal and replacement of covers of electrical equipment, open access panels, etc., to permit Owner's Representative to observe equipment and controllers provided.

E. Furnish ladders, flashlights, tools and equipment as necessary.

3.03 WORK TO RESOLVE DEFICIENCIES

A. In some systems, misadjustments, misapplied equipment and/or deficient performance under varying loads will result in additional work being required to commission the systems.

1. This work will be completed under the direction of the Owner's Representative, with input from the Contractor and equipment supplier.
2. Whereas all members will have input and the opportunity to discuss the work and resolve problems, the Owner's Representative will have final jurisdiction over the work necessary to achieve performance.

B. Corrective work shall be completed in a timely fashion to permit timely completion of the commissioning process.

1. Experimentation to render system performance will be permitted.
2. If the Owner's Representative deems the experimentation work to be ineffective or untimely as it relates to the commissioning process, the Contractor shall schedule a meeting with the Owner to discuss the nature of the problem, expected steps to be taken, and the deadline for completion of activities.
3. If deadlines pass without resolution of the problem, the Owner reserves the right to obtain supplementary services and/or equipment to resolve the problem.
4. Any costs incurred to solve the problems in an expeditious manner shall be the Contractor's responsibility.

3.04 SYSTEMS DOCUMENTATION

A. In addition to the requirements of Division 1, update contract documents to incorporate field changes and revisions to system designs to account for actual constructed configurations.

1. All drawings shall be red-lined on two sets.
2. Contractor as-built drawings to include architectural floor plans, elevations and details, and the individual electrical systems in relation to actual building layout. Dimensions from a wall or permanent structure shall be shown for any equipment, conduit, cable, etc. installed in a different location than identified in the Contract documents.
3. All IP addresses issued to electrical meters shall be documented and included in the red-line drawings.

B. Maintain as-built red-lines as required by Division 1.

1. Red-lining of drawings at completion of construction, based on memory of key personnel, is not satisfactory.
2. Continuous and regular red-lining is considered essential and mandatory.

Device Profile Report

Device Profile Report

Model:	
ID Number:	
Name:	
NVRAM:	

Firmware Versions

FirmWare	Boot	Runtime	Xilinx
Comm			
DSP			

Communication Settings

Item	Port 1	Optical	Port 4
Address			
Baud Rate			
Data Bits			
Parity			
Stop Bits 1			
Tx Delay			

Protocol			
Mode			

System Setup **Time Setup**

CT Ratio:		Time Zone:	
PT Ratio:		DST Enabled:	
		DST Start:	
Form:		DST End:	
		Line Sync:	
Frequency Range:		Frequency:	
Voltage Back			
Power Direction Label:			
Power Factor Display:			

Demand Setup **Block Window Sync**

Thermal Averaging Window:		Use Sync Pulse:	
Block Averaging Window:		High Speed Input #:	
Rolling Averaging Sub-Interval Window:		Generate End of Interval Pulse:	
Rolling Sub-Intervals:		Relay #:	
Predictive Rolling Window Average:		Pulse Width (ms):	

Limit Full Scales

Channels	Values
I A, B, C, Nc	

Flicker Settings

Short Term Test Time (PST):	
Long Term Test Time (PLT):	

I Nm	
V AN, BN, CN	
V AB, BC, CA	
V Aux	
Power Phase	
Power Total	
Frequency	

Frequency:	

I & V Squared T Thresholds

I Squared T:	
V Squared T:	

Energy, Pulses, and Accumulations in the Interval

Interval:	

Block Window Max/Min Intervals

First (Interval 1):	
Second (Interval 2)	

Transformer/Line Loss Compensation

State:	
Apply:	

%LWFE	%LVFE	%LWCU	%LVCU

Trending Log 1 Interval

Hours	Minutes	Seconds

Trending Log 2 Interval

Hours	Minutes	Seconds

Internal KYZ Settings Form C = KYC(Transition)|Form A = KY(Pulse)

KYZ Output	Assigned Channel	WattHour Per Pulse	Pulse Width (ms)	Mode	Form
1					
2					
3					
4					
Test LED					

Network Settings

IP Address	
Subnet Mask	
Default Gateway	
Gateway Port Baud Rate	
Gateway Port Delay	
MAC Address (IEEE Registered)	
Room Physical Port Address	
MDF Switch ID	
IDF Switch ID	

DNS Servers

DNS Server 1	

DNS Server 2	

Services

Modbus TCP Server	
Modbus TCP Client	
GE EDG Data Port Server	
Web Server	
SMTP Server	
SMTP Client	
FTP Server	
FTP Client	
HTTP/Modbus RTU Server	

Alarm/Email

Email Server IP Address/Name	
Email Server Port	
Email Monitor Address	
Return/Reply Address	
Email Subject Text	
Email Server Requires Authentication	
Username	
Password	

FTP Client

FTP Server IP Address/Name	
FTP Server Port	

Startup Remote Directory	
Username	
Password	

Network Card Firmware Update Via Network

Enabled	
Server Port	
Server IP Address	
Client IP Address	
Subnet Mask	
Default Gateway	
Download Filename	

GE Protocol (EDG)

IP Address for Multicast or Unicast	
Connection Type	
Update Interval	

DNP LAN/WAN Settings

Mode:	

Connection:

DNP over TCP:		Listen on Port:			
DNP over UDP:		Listen on Port:			
Respond to:					

ELECTRICAL – METER – STANDARD SPECS

STANDARD SPECIFICATIONS

This standard specification is intended to be integrated into the project specifications. The Consultant shall write the specifications to meet the project needs in consultation with the Owner and in accordance with the attached design information section.

PART 1 – GENERAL

1.01 DESCRIPTION

A. Purpose

1. This section covers electrical service meters and sub-meters for use in the Owner's power distribution systems.

1.02 QUALIFICATIONS

A. Approved manufacturers

1. Electrical Service Meters
    a. Electro Industries – Nexus 1262
    b. Electro Industries – Shark 270 with V3 Switch Pack
    c. No Substitutions Allowed
2. Electrical Sub-Meters
    a. Electro Industries – Shark 200 with V3 Switch Pack
    b. Electro Industries – Shark MP200 with V2 Switch Pack
    c. Eaton – PXMP Very features to make equal to Shark
    d. Eaton – PXM2260
    e. GE – EPM 4600 with Basic Logging
3. Test Blocks
    a. GE – PK-2 #644120G3 & PK-2 #6422420G4
    b. Marathon – 1500
    c. Buss – 15149-3
    d. Or approved equal

1.03 RELATED SECTIONS

A. 01 91 00 – General Commission Requirements

B. 26 08 00.11 – Electrical Meter Integration and Commissioning

1.04 REFERENCES

A. Applicable codes, standards, and references codes, regulations and standards

1. National Electrical Testing Association – NETA
2. National Fire Protection Association – NFPA
3. National Electrical Code - NEC
4. ANSI C12.20 – Accuracy
5. ANSI/IEEE C37.90.1 – Surge Withstand
6. ANSI C62.41 – Surge Immunity
7. IEC 1000-4-2 – ESD
8. IEC 1000-4-3 – Radiated Immunity
9. IEC 1000-4-4 – Fast Transient
10. IEC 1000-4-5 – Surge Immunity
11. IEC 1000-4-6 – Conducted Immunity
12. IEC 60068-2-6 – Vibration (Sinusoidal)
13. IEC 60068-2-27 – Shock Test
14. IEC 695-2-1 – Resistance to heat & Fire
15. IEC 68-2-1 – Cold Test
16. IEC 68-2-2 – Dry Heat
17. IEC 68-2-30 – Damp Heat
18. State and local codes and ordinances

1.05 COORDINATION

A. Coordinate Operations and Maintenance training times with the Owner.

1.06 SUBMITTALS

A. General

1. Submittals shall be in accordance with Conditions of the Contract and Division 01 Specification Sections.
2. Submit detailed maintenance manuals and drawings, which include catalog information indicating the complete electrical and mechanical characteristics.
3. Submit dimensioned cross-sectional drawings (manufacturer's data sheets are acceptable).
4. Submit finished meter tests – Manufacturer's Certified Test Reports showing compliance with ANSI C12.20 accuracy tests

1.07 OPERATIONS AND MAINTENANCE (O&M) MANUALS

A. Operations and Maintenance Manuals shall be in accordance with Conditions of the Contract and Division 01 Specification Sections.
B. Operations and Maintenance Manuals shall include catalog information indicating complete electrical and mechanical characteristics.
C. Manufacturer's Certified Test Reports
D. Manufacturer's drawings of meter wiring diagram.

1.08 MEETINGS

A. Pre-installation conference

1. The Contractor shall request a pre-installation conference with the UW Engineering Services and UW Physical Plant High Voltage Shop for projects with medium and high voltage work.

B. Attend meetings with the Owner and/or Owner's Representative as required to resolve any installation or functional problems.

PART 2 – PRODUCTS

2.01 GENERAL

A. These electrical meter specifications are in accord with the Owner's policy to construct permanent installations with long life, coupled with maximum reliability and safety.

2.02 ELECTRIC SERVICE METER

A. The following shall apply to the main electric meters at the main building service:

1. Power meter shall be multi-function 3 phase, solid-state, socket-mount design.
    a. Meter shall be capable of connection to three-phase, four-wire or three-phase, three-wire circuits.
    b. Meter shall support meter form factors 9S, 36S, and 45S.

Form	Rated Voltage	Type
9S	0 to 277 V L-N	3E, 4W, Wye
36S	0 to 277 V L-N	2 ½ E, 4W, Wye with Neutral
45S	0 to 480 V L-L	2E, 3W, Delta

2. Voltage and current inputs to the meter shall conform to the following at a minimum:
    a. Meter shall be a Class 20, transformer rated design.
    b. Monitor shall accept input of three (3) independent voltage inputs and three (3) independent current inputs of the stated capacity.
    c. Voltage inputs shall be rated for connection to circuits from 0 to 480 Volts AC line-to-neutral or 0 to 600 Volts AC line-to-line and shall be auto-ranging over this range.
    d. Voltage input shall be optically isolated to 2500 volts AC. Shall meet or exceed IEEE 37.90.1 (Surge Withstand Capability). Communication ports shall be isolated from each other to 1000 Volts.

e. Current inputs shall have a continuous rating of 120% of Class Current and a 1-second over-current rating of 500 %.

3. Power meter shall measure and report the following quantities at a minimum:

   a. Voltage, both phase to neutral and phase to phase, for all three phases; Phase angles for each voltage relative to each other.
   b. Current, phase A, B, C, and N-calculated; Phase angles for each current relative to voltages.
   c. Watts (total and per phase), VARs (total and per phase), VA (total and per phase), Power Factor (total and per phase) and Frequency.
   d. Accumulated Watt-hr, VA-hr, and VAR-hr; Watt-hr received; Watt-hr delivered. VAR-hr and VA-hr reading shall be accumulated and stored for each of the 4 quadrants of power.
   e. Power demand shall be simultaneously calculated using five (5) different averaging methods: Fixed Window (Block) Average, Sliding Window (Rolling Block) Average, Thermal Average, Predicted Average, and Cumulative Demand.
   f. Power meter shall provide time-stamped maximum and minimum readings for every measured parameter, and provide coincident VAR readings for all maximum Watt readings with time/date stamp.

4. The power meter shall compensate for errors in current transformer and potential transformer.

   a. Errors shall include voltage, multipoint current, multiphase angle, and better than .01% resolution.

5. Meter shall include an integrated LCD display with multiple display modes. The display shall be fully customizable by the user.

   a. Display shall at least support simultaneous Normal, Test, Diagnostic, and Time-of-Use modes.
   b. Normal Mode shall have fully customizable screens.
   c. Test Mode shall provide access to Wh (delivered and received), VARh (delivered and received), VAh (delivered and received), and instantaneous demand. When operating in test mode the stored readings from Normal Mode shall not be impacted or compromised.
   d. Diagnostic Mode shall provide access to all voltages and currents, a real-time phasor diagram, and real-time harmonics of each voltage and current to the 40th order. Viewing harmonics to the 128th order shall be available through a connected computer.
   e. Time of Use mode shall provide access to kWh and kW for each TOU register and total, kVARh and kVAR for each TOU register and total and kVAh for each TOU register and total.

6. Power meter shall provide multiple digital communication ports and support multiple open protocols.

a. Meter shall include an IR port for communication to external devices such as handheld readers that supports speeds of up to 57,600 bps.
b. Meter shall include a RS-485 digital communication ports. The port shall be user configurable with regard to speed, protocol, and address.
c. Meter shall have a second port configured as a 10/100BaseT Ethernet port.
d. Meter shall communicate using Modbus RTU, Modbus ASCII, and Modbus TCP/IP protocols as standard configurations. All instantaneous data, logged data, and event data, information shall be available using these open protocols. The meter shall also provide means for custom modbus mapping.
e. Meter shall include DNP 3.0 Level 2 protocol for communication to SCADA systems. All instantaneous data and average data shall be available using DNP 3.0 Level 2 protocol. User shall be able to custom map data into DNP protocol using Windows based software.

7. The meter shall internally record and store Time of Use data.

   a. The following Time of Use parameters must be included:

      i. Bi-directional consumption and demand
      ii. Eight (8) TOU Schedules
      iii. Twenty (20) Year Calendar
      iv. Four (4) seasons per year.

   b. The meter must provide the following TOU information for all rates in real-time:

      i. Current month accumulations
      ii. Previous month accumulations
      iii. Current season accumulations
      iv. Previous season accumulations
      v. Total accumulations to date
      vi. Programmable Freeze Registers
      vii. Cumulative Demand

8. Meter shall be equipped with four (4) form C pulse output channels that can be configured for operation as KYZ pulse outputs or End of Interval pulse outputs.
9. Meter shall be equipped with eight (8) pulse input channels for data collection from other meters.
10. Power meter shall be equipped with non-volatile RAM for recording logs and programming information.

    a. Meter shall include at least 512K RAM.
    b. In the event of loss of control power, data stored in memory shall be retained for at least 10 years.
    c. Meter shall store all programming and set-up parameters in non-volatile memory. In the event of loss of control power, meter programming data stored in memory shall be retained for at least 10 years. No replaceable battery shall be required.

11. Meter shall record system events for security and anti-tampering.

a. Events recorded shall include:

   i. Power up & down
   ii. Password access & modification
   iii. Change of the programmable settings & run time
   iv. Change of clock time by communication (Modbus or DNP)
   v. Test Mode usage
   vi. Meter resets (Logs, Max/Min, Energy)

12. Power meter shall be programmable by software supplied by the meter manufacturer.

    a. Software shall have a user-friendly, Windows compatible interface.
    b. Software shall operate on Windows 2000, XP, Windows 2003, VISTA, or Windows 7 operating systems.
    c. Software shall include capacity to program meter, download meter, and analyze downloaded data files.
    d. Software shall store all data in an ODBC compliant database. Data based storage shall include all log and waveform data.

13. Power meter shall be appropriately constructed to provide long life in abusive physical and electrical environments.

    a. Meter firmware shall be held in flash RAM and shall be upgradeable through one of the communications port without removing the unit from service.
    b. Meter shall have a Lexan cover. An internal cover shall protect circuit boards and energized parts from UV damage or when the Lexan cover is removed for maintenance.
    c. Meter shall operate successfully at temperature extremes from –40o C to +85o C.
    d. Meter shall operate with control power from 85 to 550 volts AC. Meter shall have a power supply option to operate with an external control power input of 85 to 275 Volts AC/DC.
    e. Meter shall have a standard 4-year warranty.

2.03 ELECTRIC METERING CABINET

A. A socket based electrical cabinet shall be supplied with the electric service meters.

1. The metering cabinet shall be an UL Type 1 or an UL Type 3R steel enclosure with factory supplied knock-outs.
2. The metering cabinet shall have a minimum dimension of 18” x 18” x 12”.
3. The metering cabinet shall be provided in multiple configurations to support meter forms 9S, 36S, and 45S.
4. The cabinet shall be lockable and provide for the application of a security seal.
5. The cabinet shall be provided with a 4 pole potential test block, a voltage fuse block, and appropriately sized fuses that are prewired to the socket base.
6. The cabinet shall be provided with a 6 pole current shorting test block prewired to the socket base.
7. Metering cabinet shall be painted ANSI Z55.1 gray finish.

2.04 ELECTRICAL SUB-METERS

A. The following shall apply to single or multi circuit meters:

1. The meter shall be UL listed.
2. Energy meter shall be designed for Multifunction Electrical Measurement on 3 phase power systems.
    a. Meter shall support 3-Element Wye, 2.5 Element Wye, 2 Element Delta, 4 wire Delta systems.
    b. Surge withstand shall conform to IEEE C37.90.1 and ANSI C62.41 (6 kV)
    c. The meter shall be user programmable for voltage range to any CT or PT ratio.
    d. Meter shall have a burden of not more than 0.36VA per phase Max at 600V, 0.014VA at 120 Volts.
    e. Meter shall have a burden of not more than 0.005VA per phase Max at 11 Amps.
    f. The meter shall accept a voltage input range from 20 up to 576 Volts Line to Neutral, and a range from 0 up to 721 Volts Line to Line.
    g. Meter shall accept a current reading of up to 10 Amps continuous. Startup current for a 5 Amp input shall be no greater than 0.005 Amps.
    h. Meter shall come standard with one solid state KYZ pulse output for remote energy pulse counting.
3. Energy meter shall allow all wiring through the front of the unit, so that the unit can be surface-mounted.
    a. Fault Current Withstand shall be 100 Amps for 10 seconds at 23oC.
    b. All inputs and outputs shall be galvanically isolated and tested to 2500 Volts AC.
    c. The meter shall accept current inputs of class 10: (0 to 10) A, 5 Amp Nominal, and class 2 (0 to 2) A Secondary, 1A Nominal.
4. The meter shall include a three-line, bright red, .56” LED display.
    a. The meter must display a % of Load Bar on the front panel to provide an analog feel. The % Load bar shall have not less than 10 segments.
    b. The sub-meter must have a programmable display, which allows for the following programming functions including automatic scroll, screen selection programming, and energy scaling.
5. Sub-meter shall be a traceable revenue sub-meter, which shall contain a utility grade test pulse, allowing power providers to verify and confirm that the sub-meter is performing to its rated accuracy.
6. The meter shall include communications ports with advanced features.
    a. Port 1 shall provide an optical IrDA port (through the faceplate) which shall allow the unit to be set up and programmed using a remote laptop without need for a communication cable.
    b. Port 2 shall be RS485. The meter shall speak Modbus RTU or ASCII protocol up to 57.6K baud.

c. Port 3 shall be 10/100BaseT Ethernet. The meter shall provide an RJ45 Ethernet connection which shall allow the unit to be assigned an IP address and communicate Modbus protocol over Ethernet TCP/IP.

7. The meter shall provide user configured fixed window or rolling window demand. This shall allow the user to set up the particular utility demand profile.
   a. Readings for kW, kVAR, kVA and PF shall be calculated using utility demand features.
   b. All other parameters shall offer max and min capability over the user selectable averaging period.
   c. Voltage shall provide an instantaneous max and min reading displaying the highest surge and lowest sag seen by the meter.
   d. The Meter shall provide upgrade rate of 6 cycles for Watts, Var and VA. All other parameters shall be 60 cycles.
8. The meter shall support power supply of 90 to 400 Volts AC and 100 to 370 Volts DC. Universal AC/DC Supply shall be available and shall have burden of 16VA Max.
9. The meter shall provide Limits Alarms and Control Capability as follows:
   a. Limits can be set for any measured parameter.
   b. Up to 16 limits per parameter can be set.
   c. Limits shall be based on % of Full Scale settings.
10. The meter shall have 2 Megabytes data-logging capability. The meter shall have a real-time clock that allows for time stamping of all the data in the meter when log events are created. The meter shall have five logs:
    a. The meter shall have three historical logs for trending profiles. Each log shall be capable of being programmed with up to 64 parameters. The user shall have the ability to allocate memory between the three historical logs in order to increase or decrease the memory allotted to each of the logs.
    b. The meter shall have a log for Limits Alarms. The Limits log shall provide magnitude and duration of an event, time-stamp, and log value. The log must be capable of recording to 2048 events.
    c. The meter shall have a log for System Events. The System Events log shall record the following occurrences with a timestamp: Demand Resets, Password Requests, System Startup, Energy Resets, Log Resets, Log Reads, Programmable Settings Changes.
11. The meter shall have a standard 4-year warranty.
12. Energy meter shall be able to be stored in (-20 to +70) degrees C.
    a. Operating temperature shall be (0 to +60) degrees C.
    b. NEMA 12 faceplate rating shall be available for the energy meter.
13. The following shall be supplied for each circuit the sub meter is to be connected to:
    a. 4 pole voltage test switch, fuse block, and appropriately sized fuses
    b. 6 pole current shorting block

c. Separate power supply for the meter.

14. Multi-Point Sub Meters shall accommodate 8-3 phase 4 wire loads.

PART 3 – EXECUTION

3.01 REQUIREMENTS

A. General installation

1. Identification
   a. Reference section 26 05 53 Identification
2. Installation
   a. Only personnel qualified and experienced in this type of work shall make connections.
   b. The installation of meters shall be done with care to avoid damage.
      i. Meters showing damage after installation shall be replaced.
      ii. Metering cabinets hung improperly shall be properly secured and all paint scratches shall be touched up.
   c. Each meter shall have dedicated CAT5E communication cable installed to connect the meter to the facility network.
   d. Meters shall be installed such that the display is no higher than 72" above the floor.
3. System Phase Sequence is C-B-A.
4. UW's Physical Plant Department High Voltage Shop will check the Contractor's work to ensure the accuracy of the connections.
   a. The Contractor shall arrange with the Owner for the times when their services will be required, and under no circumstances shall the Contractor connect to the existing system without Owner's knowledge.
   b. The proper connection of the wires and cables to other systems as specified is entirely the responsibility of the Contractor.
   c. In the event the connections cannot be made as specified, the Contractor shall make the necessary corrections at his own expense.
5. Install meters per manufacturer's recommendations.

B. Mounting and electrical connections

1. In accordance with manufacturer's installation instructions.
2. Install a dedicated 120V circuit from panelboard to provide power to the electrical meter in a dedicated RGC/IMC. (if required)

C. UL Listing

1. The Contractor shall ensure that the metering installation is UL Listed.

D. Integration and Commissioning

1. See Electrical Meter and SCADA Integration and Commissioning

DATA COLLECTION CONTROLLER – STANDARD SPECS

STANDARD SPECIFICATIONS

This standard specification is intended to be integrated into the project specifications. The Consultant shall write the specifications to meet the project needs in consultation with the Owner and in accordance with the attached design information section.

PART 1 – GENERAL

1.01 DESCRIPTION

A. Purpose

1. This section covers data collection controllers for use in the Owner's systems.

1.02 QUALIFICATIONS

A. Approved manufacturers

1. Data Collection Controllers

a. UW Meter PLC Cabinet, Contractor to contact Campus Utilities and Operations

1.03 RELATED SECTIONS

A. 01 91 00 – General Commission Requirements

B. 23 08 00.11 – Mechanical Meter Integration and Commissioning

1.04 REFERENCES

A. Applicable codes, standards, and references codes, regulations and standards

1. National Electrical Testing Association – NETA
2. National Fire Protection Association – NFPA
3. National Electrical Code - NEC
4. UL 916 – Energy Management Equipment
5. State and local codes and ordinances

1.05 COORDINATION

A. Coordinate the quantity and location of Facility Network (Facnet) Ethernet ports with Campus Engineering & Operations and UWIT. Contractor shall provide a completed “Mechanical Meter Profile Report” form per Specification 23 08 00.11 Appendix A for each meter.

1.06 OPERATIONS AND MAINTENANCE (O&M) MANUALS

A. Operations and Maintenance Manuals shall be in accordance with Conditions of the Contract and Division 01 Specification Sections.
B. Operations and Maintenance Manuals shall include catalog information indicating complete electrical and mechanical characteristics.
C. Manufacturer's Certified Test Reports

1.07 MEETINGS

A. Pre-installation conference

1. The Contractor shall request a pre-installation conference with the UW Engineering Services for projects requiring the installation of or the connection to a data collection controller.
2. The Contractor shall request a pre-installation conference with Campus Utilities and Operations before project begins construction.

B. Attend meetings with the Owner and/or Owner's Representative as required to resolve any installation or functional problems.

PART 2 – PRODUCTS

2.01 DATA COLLECTION CONTROLLER(S) AND CABINET(S)

A. Provided by Campus Utilities and Operations. Project shall reimburse the Campus Utilities and Operations for cost of the controller and cabinet.
B. Capacity

1. Each data collection controller is capable of collecting 64 input points. The project shall coordinate input point quantity with the Campus Utilities and Operations to supply sufficient controllers and cabinets.

PART 3 – EXECUTION

3.01 REQUIREMENTS

A. General installation

1. Identification

a. Reference section 26 05 53 Identification

2. Installation

a. Only personnel qualified and experienced in this type of work shall make connections.

b. The installation of data collection controllers shall be done with care to avoid damage.
    i. Controllers showing damage after installation shall be replaced.
    ii. Controllers hung improperly shall be properly secured and all paint scratches shall be toughed up.
    iii. Data collection controller cabinets hung improperly shall be secured and all paint scratched shall be touched up.
c. Each controller shall have dedicated CAT5E communication cable installed to connect the controller to the facility network. UW shall make communication cable terminations. Communication conduit shall be 1" minimum.
d. Controllers shall be installed no higher than 72" above the floor.
e. Wire labels shall be machine made shrink type labels.
f. All wire must be unbroken from source to endpoint.
g. No penetrations shall be made in the back or wire way of data collection controller.
h. Penetrations made in the top of the data collection controller shall "Myers Hub" installed.
i. IT Termination Box
    i. Shall be 12" x12" x 6" (B-Line #12126-1) with keyed lock #1333 Dirak.
    ii. Must be located in a serviceable location within 10' of data collection controller.
    iii. Label (Brother P-touch or equal) shall be installed on inside cover indicated IT Room that service is from.
j. Owner shall verify installation prior to energizing data collection controller.

3. The System Integrator will check the Contractor's work to ensure the accuracy of the connections.
    a. The Contractor shall arrange with the Owner for the times when their services will be required, and under no circumstances shall the Contractor connect to the existing system without Owner's knowledge.
    b. The proper connection of the wires and cables to other systems as specified is entirely the responsibility of the Contractor.
    c. In the event the connections cannot be made as specified, the Contractor shall make the necessary corrections at his own expense.
4. Install controllers per manufacturer's recommendations.

B. Mounting and electrical connections
    1. In accordance with manufacturer's installation instructions.
    2. A dedicated 120VAC circuit from a panelboard to the data collection controller with #12 THHN/THWN in a dedicated GRC/IMC. Panelboard must be clearly labeled to show feed to data collection controller.
    3. Owner to verify power cable installation, and energize circuit after inspection.

C. UL Listing

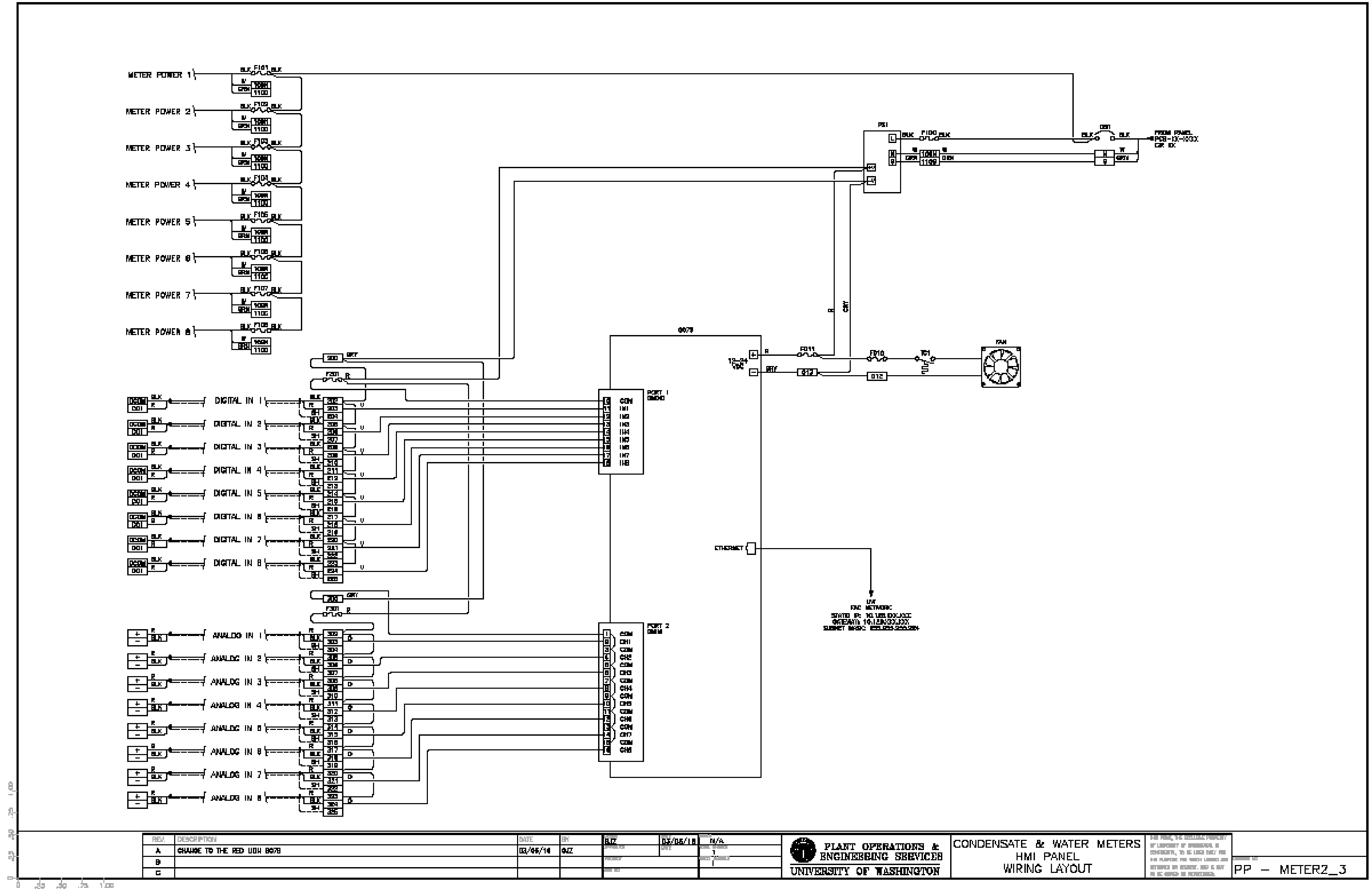
1. The Contractor shall ensure that the controller installation is UL Listed.

D. Testing

1. Provide testing as required per Division 26 Inspection, Calibration and Testing.

E. Integration and Commissioning

1. See section D Mechanical Meter Integration and Commissioning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PLANT OPERATIONS & ENGINEERING SERVICES
UNIVERSITY OF WASHINGTON
CONDENSATE & WATER METERS
HMI PANEL
WIRING LAYOUT
PP – METER2_3

E. Automatic Transfer Switches (ATS)

Basis of Design

This section applies to the design and installation relating to automatic transfer switches (ATS).

For the Automatic Transfer Switches (ATS) Standard Specifications click here.

Design Criteria

1. Clearly indicate in the drawings and specifications whether the PNP, NPNP and/or BIS style switches and are required. Eliminate sections of the attached standard specifications as required.
   a. Specify Non-Programmed Neutral Position ("NPNP") for NEC 517 and NEC 700 emergency systems.
   b. Specify Programmed Neutral Position ("PNP") for NEC 701 and NEC 702 legally required and optional standby systems and for systems that contain significant motor loads that would benefit from the neutral position for motor run down prior to restart.
   c. Specify Bypass Isolation Switch (BIS) for all Medical Center applications and Health Sciences and major research lab applications that cannot tolerate prolonged shutdowns of the emergency system for maintenance. BIS is typically required where critical client equipment and systems are connected to the emergency system. Examples include freezers, bio-safety cabinets, life sustaining processes like pumped water to fish tanks, systems providing protection of facilities and personnel from environmental hazards, and equipment protecting facilities from damage, e.g. sanitary lift stations and sump pumps.
   d. Specify CMCS integration for the University of Washington Medical Center.
2. Clearly indicate in the drawings and specifications whether CMCS monitoring and control provisions are required. Eliminate the appropriate sections of the attached standard specifications if the CMCS features are not required.
   a. Seattle Campus: No new or renovated buildings outside the University of Washington Medical Center (UWMC) will be added to the CMCS System. The UWMC transfer switches will be integrated into the CMCS System.
   b. Other UW Campuses and outlying facilities: CMCS monitoring and control is not required. Consult with UW Engineering Services to determine what, if any, site specific load management, monitoring and control functionality is required.
   c. For transfer switches integrated into the CMCS system, coordinate with switchgear specifications to provide contacts for emergency feeder breaker position and emergency breaker truck position.

Submittals

1. Provide standard industry submittal requirements.

2. Refer to attached Automatic Transfer Switch standard specifications.

Related Sections

1. Building Systems
2. Emergency Systems

Products, Material and Equipment

1. Russelectric, no exception:
   a. UW Class E1 and E2 emergency services.
   b. Bypass/Isolation (BIS) style transfer switches.
2. Russelectric and other manufactures pre-approved by Engineering Services:
   a. UW Class E3 and E4 emergency services.
   b. Outlying UW Campuses, and other remote facilities.
   c. By-pass/isolation (BIS) not required.
   d. For each project, transfer switches shall be of the same manufacturer.
3. Circuit breaker style transfer switches are not acceptable.

Installation, Fabrication and Construction

1. Refer to attached Automatic Transfer Switch standard specifications.

AUTOMATIC TRANSFER SWITCHES – STANDARD SPECS

STANDARD SPECIFICATIONS

This standard specification is intended to be integrated into the project specifications. The Consultant shall write the specifications to meet the project needs in consultation with the Owner and in accordance with the attached design information section.

> ***IMPORTANT:*** *The Consultant shall clearly indicate in the drawings and specifications whether the PNP, NPNP and/or BIS style switches are required. Eliminate the appropriate sections of this specification if the PNP and/or the BIS features are not required.*

PART 1 – GENERAL

1.01 DESCRIPTION

A. Automatic transfer switches (ATS)

1. Styles and features

Consultant shall indicate PNP, NPNP and BIS requirements here. See the guidelines listed above.

1.02 QUALIFICATIONS

A. Pre-approved transfer switches

Consultant shall specify the approved manufacturers based on the criteria defined in the introduction to this standard specification.

1. Approved manufacturer: Russelectric.
2. For each project, transfer switches shall be of the same manufacturer.
3. Pre-approval subject to the manufacturer's ability to meet ALL of the specification requirements.

B. Pre-approved accessories

1. Selector switches shall be Electro-Switch, Series 24 or approved equal.
2. Russelectric RPTC Microprocessor based control system
3. Electro Industries Gauge (EIG) 200 Shark Meter I/O with Ethernet and Relay outputs cards.

1.03 RELATED SECTIONS

A. The work under this section is subject to requirements of the contract documents, including the **GENERAL CONDITIONS, SUPPLEMENTAL CONDITIONS,** and sections under Division-1 **GENERAL REQUIREMENTS**.

B. Equipment identification
C. Requirements in support of the commissioning process
D. Structural drawings and specifications for housekeeping pad construction details.

1.04 REFERENCES

A. Applicable codes, standards, and references

1. National Electrical Code - NEC
2. National Electrical Testing Association – NETA
3. UL 1008 – Automatic Transfer Switches
4. National Fire Protection Association – NFPA
5. State and local codes and ordinances

1.05 COORDINATION

A. Coordinate with Inspection, Calibration and Testing section.
B. Coordinate Operations and Maintenance training times with the University.

1.06 SUBMITTALS

A. General

1. Submittals shall be in accordance with Conditions of the Contract and Division 01 Specification sections.
2. Submit detailed maintenance manuals and drawings, which include wiring diagrams, dimensions, front and side views and catalog information indicating complete electrical and mechanical characteristics.

1.07 OPERATIONS AND MAINTENANCE (O&M) MANUALS

A. Operations and Maintenance Manuals shall be in accordance with Conditions of the Contract and Division 01 Specification Sections.
B. Operations and Maintenance Manuals shall include but not be limited to wiring diagrams, bus layout drawings, dimensions, front and side views and catalog information indicating complete electrical, mechanical characteristics, startup and testing reports.

1.08 MEETINGS

A. Attend meetings with the Owner and/or Owner's representative as required to resolve any installation or functional problems.

PART 2 – PRODUCTS

2.01 AUTOMATIC TRANSFER SWITCH AND BYPASS ISOLATION SWITCH

A. General

1. Each transfer switch shall be enclosed in NEMA-1 general-purpose enclosure with front opening lockable doors. Access into enclosure shall be from the front.
2. All components of the assembly except those identified in these specifications by the manufacturer shall be a regularly manufactured product of the supplier.
3. Nameplates: Identify all equipment, operating handles, and devices on structure (exterior and interior) with engraved plastic laminated nameplates (red background with white lettering). Engraving shall identify equipment, emergency classification and supply sources to match nomenclature identification shown on equipment schematic and wiring diagrams.
4. Provide microprocessor based control system that includes:
    a. Setup, alarm acknowledgement, and review of actual data are accomplished using the controller’s soft keys and VGA color display. The menu should be able to guide the user through controller setup and the entering of configuration data, including communications and timing set points, adjustable control parameters (interlocks, alarms and security), and event logging.
    b. Real-time metering of voltage (phase-to-phase and phase-to-neutral), current and power; frequency of both sources; power quality with waveform capture and historical trending.
    c. Senses Source 1 (usually the electric utility source) and Source 2 (usually the engine generator source) voltages and, by means of easy-to-see LEDs, indicates switch position and source availability. Through the menu, the user shall be able to review operational data such as active time delays, transfer inhibits, metered values, fault and alarm reports, event records, and configuration settings. The controller also automatically displays the status of monitored conditions in color-coded banners at the top of the VGA screen including faults and alarms, inhibits, and informational messages.
    d. Two communication interfaces - standard Modbus RTU and Modbus TCP/IP via 10/100 Base-T Ethernet
    e. An external USB communication port on the controller’s faceplate.
    f. Controller design shall accommodate the addition of accessories.
5. Identify all control wire terminations by tubular sleeve-type markers to agree with wire marking identification on manufacturer's equipment drawings.
6. Indicating lamps shall be LED.
7. All transfer switches shall be provided with a connection to the UW FacNet system.

B. Automatic transfer switch ratings and performance

1. Transfer to emergency and re-transfer to normal source shall be automatic. Once initiated, NPNP transfer time shall not exceed 1/20th of one second. UL 1008 listed meeting tables 21.1, 23.1, 23.2.
2. The transfer switch shall be capable of transferring successfully in either direction with 70% rated voltage applied to the switch terminals.
3. Each automatic transfer switch shall be rated at 480 volts, 3 phase, 4 pole, for 60 Hertz, normal and emergency sources.

4. All current-carrying parts shall have full 600-volt insulation.
5. The automatic transfer switch and bypass/isolation switch shall have 42,000 Amps minimum RMS short circuit withstand and closing rating when connected to the load side of standard circuit breakers (not current limiting).

C. Construction

1. For NPNP applications, the transfer switch actuator shall be double throw, single electrical operator, momentarily energized; connected to the transfer mechanisms by a simple over-center-type linkage.
2. The transfer switch shall be equipped with a permanently attached safe manual operator design to prevent injury to operating personnel. The manual operator shall provide the same contact-contact transfer speed as the electrical operator to prevent switching the main contacts slowly, and shall allow for manual transfer under full load.
3. The normal and emergency contacts shall be positively interlocked mechanically and electrically to prevent simultaneous closing.
4. Main contacts shall be mechanically locked in position in both the normal and emergency positions.
5. Main contacts: Silver tungsten alloy. Separate arcing contacts, with magnetic blowouts. Interlocked molded case circuit breakers or contactors are not acceptable.

D. The automatic transfer switch features and accessories:

1. All contacts shall be Form-C dry contacts and wire to a dedicated terminal strip for easy access and connection to remote system.
2. Number the terminals clearly and sequentially with labels indicating which function each terminal block represents.
3. Acceptable nomenclature is “Normal Position (N.O.)” or “Normal Position (Common)” where (N.O.) is the normally open contact and common is common with both (N.O.) and (N.C.).
4. Required remote monitoring contacts and signals
    a. Normal position; four auxiliary contacts closed in normal position (Russelectric #14ax).
    b. Emergency position; four auxiliary contacts closed in emergency position (Russelectric #14bx).
    c. Automatic switch truck position (Russelectric # IS). Normally open dry contact that closes when the ATS is isolated
5. Adjustable close differential 3-phase sensing relay energized from the normal source, factory set to pick up at 90% and drop out at 80% of rated voltage. Potential transformers shall be multi-tap for either 208V or 480V sensing (Russelectric #VSN).
6. Time delay to override momentary normal source power outage, to delay transfer switch operation; adjustable 0.5 3 seconds, factory set at 3 seconds (Russelectric #1d).
7. Time delay on transfer to emergency; pneumatic type, adjustable 1-300 seconds, factory set at 3 seconds (Russelectric #2b).

8. Time delay on re-transfer to normal while in emergency position. Motor driven type, adjustable 0-30 minutes, factory set at 5 minutes. This time delay shall be overridden upon failure of the emergency source (Russelectric #3a).
9. Four-position selector switch with "Manual", "Off", "Auto", "Test" positions
    a. Manual: Permits pushbutton transfer to normal or emergency
    b. Off: Override to bypass the automatic transfer switch controls so that the transferred switch will remain indefinitely connected to the power source (emergency, normal, or neutral) regardless of the condition of the power sources.
    c. Automatic: All control features ready for automatic sensing and transfer (Exception: Remote control has priority over this switch position) (Russelectric #12a).
    d. Test: Simulates normal power failure with the load test relay (Russelectric #5c).
10. Pushbutton re-transfer to normal, operable only when the 4 position selector switch (Russelectric #6f) is in the manual position.
11. Pushbutton transfer to emergency, operable only when 4 position selector switch is in the manual position (Russelectric #6g).
12. Green LED pilot light to indicate switch in normal position (Russelectric #9a).
13. Red LED pilot light to indicate switch in emergency position (Russelectric #9b).
14. Meters using Cutler Hammer IQ200s with selector switches to read current in all three phases of load circuit. Provide shorting block and terminals for connection of 5 Amp transducer to the current transformers (Russelectric #18b).
15. Voltmeter with 7-position selector switch marked “3-1”, “2-3”, “1-2”, “Off”, “1”, “2”, “3”. Three-phase type to read phase-to-phase and phase-to-neutral voltage of the load for 4-pole ATSs. (Russelectric #18b).
16. KW and KVAR: Monitor on the load side of the transfer switch with Watt/Var transducers and related hardware. Transducer outputs shall be 4-20ma corresponding to the actual load. Hardware provided should be isolated from all other normal switch operational wiring. Include: P.T. and C.T. fuse protection, facilities for portable testing equipment (e.g. G.E. type "PK-2" test blocks), C.T. shorting blocks.
17. Loss of normal power: Six auxiliary contacts to close on failure of normal source. When applicable, these contacts shall initiate building emergency power procedures: Engine generator start contacts, HVAC control, elevator shutdown, fire alarm annunciation, etc. (Russelectric #7).
18. Contacts operated from voltage sensing network (VSN) to open on failure and close on restoration of normal source (to CMCS signal) (Russelectric #VSN).
19. Loss of emergency power: Terminals and contacts (3-amp 125 VAC) for remote monitoring of emergency source status (within voltage and frequency limits; not within voltage and frequency limits) (Russelectric #21x).
20. Derangement: Interconnect the following contacts (normally closed) such that any open contact indicates "off normal" condition, including the following:
    a. Manual/Off/Auto/Test selector switch (acc. 12) is in manual, off, or test position.
    b. Automatic mechanism of switch is fully isolated (drawn out of the cubicle).

21. Adjustable relay to prevent transfer to emergency until voltage and frequency of generating plant have reached acceptable limits. Factory set at 90% of rated value (Russelectric #21).

E. Sequence of operation

1. Contacts shall be provided to initiate an emergency operation (i.e., elevator or HVAC equipment shutdown) should the voltage of the normal source drop on any phase after an adjustable time delay of 0.5 -3 seconds to allow for momentary dips.
2. The transfer switch shall transfer to emergency when rated voltage and frequency has been reached.
3. After restoration of normal power on all phases, an adjustable time delay period of 0 to 30 minutes shall delay the automatic re-transfer to allow stabilization of normal power. If the emergency power source should fail during this time delay period, the switch shall automatically and immediately return to the normal source or neutral position.
4. A maintained contact test switch shall be included to simulate normal power failure, and pilot lights shall be mounted on the cabinet door to indicate the switch position. Operation of test switch shall cause a derangement signal.

Consultant to include the next section for PNP style transfer switches

F. PNP switches

1. PNP applications, the transfer switch actuator shall be dual electrical operators, momentarily energized, and connected to the transfer mechanisms by a simple over-center-type linkage, with a total transfer time that is adjustable between 0 and 300 seconds.
2. PNP transfer switch styles, provide time delay relays to control contact transition time by suspending contact mechanism in neutral (off) position on transfer to either source, adjustable 1-300 seconds, factory set at 3 seconds. Timing shall start upon failure of old source. Provide terminals for remote contact control (3Amp, 120 Volt from the CMCS by others) to override relay and force ATS to assume the neutral (off) position, regardless of time delay relay status; for use in load shedding (Russelectric #2dx).
3. PNP transfer switch styles, provide a LED pilot light with a flashing lamp, which indicates when either the load shed or block transfer relays are energized (Russelectric LSBTR).
4. PNP transfer switch styles: Provide a maintained two-position selector switch for load shed or block transfer enable/disable. This switch shall be capable of being sealed in either position with a lead or plastic tamper indicating seal. Provide contacts for remote monitoring when this switch is placed in the disable position.
5. PNP applications: Provide adjustable time delays for transferring from the normal to the neutral position and from the neutral to the emergency position. A Load Shed signal shall initiate action that removes the load from the emergency source.
6. Each PNP transfer switch shall have a Load Shed Enable/Disable switch. This switch determines if the Central Management Control System (CMCS) has control.
7. PNP transfer switch styles: The CMCS shall have the ability to control loads on the campus emergency feeder system. Load Shed control takes (predetermined) prioritized loads off the system. Block transfer control permits the proper loading of the system

when the generators come on line. This control shall be combined into one output signal from the CMCS.

8. Required PNP monitoring and control equipment, contacts and signals:
   a. Neutral position; four auxiliary contacts closed in neutral position.
   b. Load shed keyswitch; closed when keyswitch enabled
   c. Load Shed keyswitch; enables/disables remote load shed control

Consultant to include the next section for BIS style transfer switches

G. Bypass/Isolation Switch (BIS)

1. Automatic transfer switch and its associated bypass/isolation switch (BIS), shall be mounted in a freestanding enclosure, and bussed together with copper bus to provide a complete and pre-tested factory assembly. Construction shall be such that the installation contractor needs only to make the incoming power and control wiring connections.
2. Bypass/isolation switches (both normal to load and emergency to load) shall provide safe and convenient means for manually bypassing and isolating the ATS, regardless of the position or condition of the ATS, with the ability to be used as an emergency backup system in the event the transfer switch should fail. In addition, the bypass/isolation switch shall be utilized to facilitate removal of the automatic transfer switch for maintenance and repair.
3. The automatic transfer switch shall be completely isolated from the bypass/isolation switch by means of insulating barriers and separate access doors to positively prevent hazard to operating personnel while servicing or removing the automatic transfer switch.
4. Provide feeder entrance compartment at the top of switch.
5. Transfer switch removal: Provide drawout-type transfer switch that when withdrawn from its operational position is supported on a rail assembly for ease of maintenance.
6. Operation of the BIS to either normal or emergency shall be possible without changing and regardless of the position of the automatic transfer switch. Overlapping contact bypass/isolation switches that are dependent upon the position of the ATS for proper operation are not acceptable.
7. Provide indicating lights to show the bypass/isolation switch in the bypass position, in fully isolated position, and to indicate source availability. Derangement signal shall only indicate the fully isolated position (drawn out of the cubicle).
8. Accomplish positive sequencing of all contacts, with mechanical linkage which prevents delay in intermediate position, through the manual operators from a dead front location.
9. Electrical testing and maintenance of the automatic transfer switch shall be possible in the bypass position.
10. Inherent double throw (break-before-make) operation shall provide positive assurance against accidental interconnection of the normal and emergency power sources. Arrangements utilizing interlocking of single-throw devices are not acceptable.
11. The operating speed of the contacts shall be independent of the speed at which the handle is moved.

12. The BIS switch shall be fully manually operable and shall not be dependent upon electrical interlock, operators, or relays for operation.
13. All main contacts and operating linkages of the BIS shall be identical to the ATS except that the operation shall be manual, and the switch shall give the same electrical ratings of ampacity, voltage, short circuit withstand, and temperature rise capability as the associated ATS. The bypass and emergency switch shall be mechanically locked in both the normal bypass and emergency bypass positions without the use of hooks, latches, magnets, or springs and shall be silver-tungsten alloy, protected by arcing contacts with magnetic blowouts on each pole.
14. The primary buswork of the drawout automatic transfer switch shall be connected to the stationary bus stabs in the freestanding cubicle by silver-plated, segmented, self-aligning, primary disconnect stabs to facilitate proper alignment between the removable drawout element and the stationary cubicle. The ATS stab assemblies shall be drawn out when the ATS is withdrawn and shall be available for inspection without disturbing or de-energizing the main bus.
15. Similarly, the secondary control disconnect contacts mounted on the ATS shall be self-aligning and shall plug into the stationary elements mounted on the freestanding cubicle. Separate, manual, secondary control disconnect plugs are not acceptable.
16. Provide the ATS with self-contained extension rails, rollers, or casters to allow it to be rolled from its enclosure by one person.
17. Provide positive mechanical interlocks to ensure that the drawout functions can be accomplished without the danger of a short circuit.
18. Required BIS monitoring contacts and signals
    a. Bypassed to emergency position
    b. Bypassed to normal position

H. Central Monitoring and Control System (CMCS) Points List:

1. The transfer switches shall have the capability of being supervised by the CMCS (Central Monitoring and Control System.)
    a. KW and KVAR
    b. Loss of normal power
    c. Loss of emergency power
    d. Derangement:
    e. Enclosure intrusion.
    f. Auto switch.
    g. Load Shed keyswitch.
    h. Normal position.
    i. Neutral position.
    j. Emergency position.
    k. Bypassed to emergency position.
    l. Bypassed to normal position.
    m. Automatic switch truck position.

PART 3 – EXECUTION

3.01 REQUIREMENTS

A. Installation, mounting and electrical connections

1. In accordance with manufacturer's installation instructions and Seismic Zone 3 requirements
2. Install floor mounted transfer switches on housekeeping pads. Housekeeping pads may present difficulties to remove the automatic switching mechanism for maintenance for large and heavy switches, usually 1000A and larger. For large switches, do not use pads but provide other means to prevent dust and debris from entering switch enclosures.
3. Coordinate remote monitor and control signal connections with the University.

B. Training

1. Provide operation and maintenance training by a factory-trained instructor for two 2-hour sessions of on-site training for a total of 6 maintenance personnel.
2. Include troubleshooting, repair and maintenance manuals for each participant.

C. Testing

1. Provide factory field startup and testing services to assist the ETC (Electrical Testing Contractor) per the Inspections, Calibration and Testing section.

F. Medium Voltage Switchgear

Basis of Design

This section applies to the design and selection of medium voltage switchgear, primarily for use in substations.

Design Criteria

1. 13.8kV equipment shall be 15kV class, 4.16kV and 2.4kV equipment shall be 5kV class.
2. Equipment must match existing campus switchgear used in similar applications.
3. Stacked cubicles shall have cable entrances arranged to allow independent operating clearances for all devices and connecting cables, e.g., offset cable entrances and chimneys in termination compartments.
4. Place control wiring in raceways where possible. Where supported with tie wraps, the ties shall be bolted or screwed to their compartment wall. Adhesive supports are not acceptable.
5. The enclosures shall have hinged padlockable metal doors on the front and rear of each cubicle (separate doors for upper and lower compartments).
6. Design cubicle heaters to operate at half voltage (208V equipment energized at 120V).
7. Ground bus attachments shall be via A. B. Chance studs.
8. Provide bus to cable termination connections with removable boot insulating covers.
9. Main bussing shall run continuously through the lineup and shall include a full sized neutral bus, isolated and supported in the same manner as the phase busses.
10. Bus material shall be copper, silver plated at connection points.

Design Evaluation

The following information is required to evaluate the design:

1. Programming Phase: Describe proposed site, power rating, and connection arrangement (ring bus, preferred/alternate, etc.)
2. Schematic Design Phase: Describe proposed equipment location, sizes, ratings and space requirements for equipment replacement routing.
3. Design Development Phase: Describe final equipment sizes and ratings. Provide an outline specification and protection/coordination requirements.
4. Construction Document Phase: Final plans, including front elevation & section views, fault bracing & seismic anchoring information. Detail drawings showing shipping splits, assembly data, and wiring diagrams. Complete coordination study and final specifications.

Submittals

1. Furnish with each metal-enclosed switchgear assembly a set of drawings complete with a bill of material and showing the following: Typical front views and open side views for each bay as well as typical components, their positions, and available space for cable termination; an anchor bolt plan with dimensions; a one-line diagram; and appropriate wiring diagrams.

2. Comprehensive instruction manual for installation and operation of each component
3. Certification of ratings of the basic switch and fuse components and the integrated metal-enclosed switchgear assembly consisting of the switch and fuse components in combination with the enclosure(s)
4. Certification of voltage, current, fault, and BIL ratings
5. Metering equipment and ratings
6. Protective equipment shop drawings
7. Manufacturer's technical bulletins for each protective relay or device
8. Component lists
9. Nameplate schedule
10. Factory and on-site testing procedures
11. Factory test records
12. Shipping split and bus connection procedures
13. Leveling requirements and tolerances

Products, Material and Equipment

1. Approved Switchgear manufacturers:
   a. ASCO-Delta
   b. Russelectric
   c. Cutler Hammer
2. Power Circuit Breaker manufacturer:
   a. Cutler Hammer Vacuum Breakers (VCP-W), no exceptions

Installation, Fabrication and Construction

1. Incoming line section shall consist of one or more air load interrupter switch(es), quick-make, quick-break, three-pole, gang operated.
2. The switchgear assembly shall consist of individual vertical sections housing combinations of circuit breakers and auxiliary equipment, bolted together to form a rigid metal-clad assembly with grounded steel barriers between compartments.

Enclosure Construction

1. Construct metal-enclosed switchgear in accordance with the minimum construction specifications of the fuse and switch manufacturer to provide adequate electrical clearances and space for fuse handling.
2. Give consideration to all relevant factors such as controlled access; tamper resistance; corrosion resistance; protection from ingress of rodents, insects, and weeds; arcing faults within the enclosure.
3. Each bay shall be shall be unitized monocoque construction to maximize strength, minimize weight, and inhibit corrosion.
4. Each bay containing high-voltage components shall be a complete unit in itself, with full side sheets resulting in double-wall construction between bays. Side and rear sheets shall not be externally bolted to guard against unauthorized or inadvertent entry.

5. To guard against corrosion, all hardware, all operating-mechanism parts, and other parts subject to abrasive action from mechanical motion shall be nonferrous materials, galvanized, or zinc-nickel-plated ferrous materials. Cadmium-plated ferrous parts shall not be used.
6. Do not use externally accessible hardware for support of high-voltage components or switch-operating mechanisms within the switchgear.
7. The integrated switchgear assembly shall have a BIL rating established by test.

Door Construction

1. Doors shall have 90-degree flanges and shall overlap with the door openings. Weld door flanges at the corners and form with a double bend so that the sheared-edge flanges at the top and both sides fold back parallel to the inside of the door.
2. Door handles shall be padlockable and, on outdoor gear, shall incorporate a hood to protect the padlock shackle from tampering.
3. Provide at least three concealed, interlocking, high-strength latches for doors over 40 inches in height. Provide doors that are less than 40 inches in height with 2 latches.
4. Doors giving access to interrupter switches or interrupter switches with power fuses shall be provided with a wide-view window and constructed of an impact-resistant material to facilitate checking of switch position without opening the door.
5. Provide doors giving access to high-voltage components with a sturdy, self-latching door holder which shall be zinc-nickel plated and chromate dipped. Provide full-height hinged covers over low-voltage compartments with a galvanized rod-type door holder. In addition provide an internal protective screen, bolted closed, to guard against inadvertent entry when the enclosure door is open.
6. Doors giving access to fuses or fused voltage transformers shall have provisions to store spare fuse units, refill units, or interrupting modules.

Insulators and Bushings

1. The interrupter switch and fuse-mounting insulators, main-bus support insulators, insulated operating shafts, and push rods shall be of a cycloaliphatic epoxy resin system, with homogeneity of the cycloaliphatic epoxy resin throughout each insulator to provide maximum resistance to power arcs.
2. Provide isolating through-bushings for the switchgear assembly between all bays to guard against the propagation of a fault from one bay into the adjacent bay.
3. For outdoor or drip-proof applications, install a drain channel above the isolating through-bushings as a backup for the bay-to-bay gasketing to prevent moisture from the bushing or the bus.
4. The bushings shall be of a nontracking, self-scouring, nonweathering cycloaliphatic epoxy resin. Such bushings shall be the only dielectric insulating material between the energized bus conductor and the ground plane. Isolating systems that incorporate multiple insulating materials in series shall not be acceptable.

5. The overall length of the bushing shall be a maximum of 9½ inches from end to end. The bushings shall provide a minimum of 12½ inches of leakage distance between the energized bus conductor and the ground plane.
6. The bus conductor shall not be molded or cemented into the bushing.
7. Do not cover the bus conductors with any insulating material in an effort to achieve BIL or increased leakage distance at locations where the bus passes through the bays.
8. Close openings between the bushings and bus conductors with a semiconducting grommet. Fiberglass or porcelain shall not be used for such purpose.
9. Bushing bus conductors and main bus conductors shall be designed for direct connection and shall not require laminated or flexible bus connections.

High-Voltage and Ground Bus

1. Bus supports, bus, and interconnections shall withstand the stresses associated with short-circuit currents up through the maximum rating of the switchgear.
2. Equip bus to where cable will be terminated with grounding provisions. Provide grounding provisions on the ground bus in such bays as well. Shop grounding pigtails use Salisbury ground ball studs.
3. Bus and interconnections shall consist of copper bar CA110, square edge, hard temper per ASTM B187. Bolted copper-to-copper connections shall have silvered interfaces and shall be made with ½"—13 stainless-steel bolts with two brass flat washers per bolt, one under the bolt head and one under the nut, and with a stainless-steel split lockwasher between the flat washer and the nut. Tighten these bolts to 35 foot-pounds torque.
4. Provide a ground bus of short-circuit rating equal to that of the integrated assembly (or ground connection, in single-bay switchgears), maintaining electrical continuity throughout the switchgear.
5. In each bay, bolt the ground bus (or connector) to a nickel-plated steel bracket which shall be welded in place.
6. For multi-bay metal-enclosed switchgear assemblies, provide two ground cable connectors accommodating No.2 through 500 Kcmil conductors for connection of ground bus to station ground.

Power Circuit Breakers

1. Provide Eaton vacuum breakers (VCP-W), metal enclosed, drawout, motor operated, with auxiliary contacts for remote monitoring of open, closed, and alarm conditions.

Protective Bus Relays

1. Provide Schweitzer relays.

Finish and Features

1. Achieve full coverage at joints and blind areas by processing enclosures independently of components such as doors and roofs before assembly into the unitized structures.

2. All surfaces shall undergo a thorough pre-treatment process comprised of a fully automated system of cleaning, rinsing, phosphatizing, sealing, drying, and cooling before any protective coatings are applied.
3. For outdoor switchgear, after pretreatment, apply protective coatings to resist corrosion and protect the steel enclosure. Representative test specimens coated by the enclosure manufacturer's finishing system shall satisfactorily pass the following tests:

   a. 4000 hours of exposure to salt-spray testing per ASTM B 117 with Underfilm corrosion not to extend more than 1/32 inch from the scribe as evaluated per ASTM D 1654, Procedure A, Method 2 (scraping). Loss of adhesion from bare metal not to extend more than 1/8 inch from the scribe.
   b. 1000 hours of humidity testing per ASTM D 4585 with no blistering as evaluated per ASTM D 714
   c. 500 hours of ultraviolet accelerated weathering testing per ASTM G 53 using lamp UVB-313 with no chalking as evaluated per ASTM D 659, and no more than a 10% reduction of gloss as evaluated per ASTM D 523
   d. Crosshatch adhesion testing per ASTM D 3359 Method B with no loss of finish
   e. 160-inch-pound impact followed by adhesion testing per ASTM D 2794 with no paint chipping or cracking
   f. Oil resistance testing consisting of a 72-hour immersion bath in mineral oil with no shift in color, no streaking, no blistering, and no loss of hardness
   g. 3000 cycles of abrasion testing per ASTM 4060 with no penetration to the substrate

4. For outdoor enclosures, apply a heavy coat of insulating "no-drip" compound to the inside surface of the roof to prevent condensation.
5. The finish shall be light gray, satisfying the requirements of ANSI Standard Z55.1 for No. 61 or No. 70. - or shall be olive green, Munsell 7GY3.29/1.5 for outdoor switchgear. Include an inside baffle with louvered openings. Vents for outdoor switchgear shall be rain-resistant, corrosion-resistant, and shall have an inside screen.
6. Lifting eyes shall be removable. Sockets for lifting eyes shall be blind-tapped.
7. For outdoor switchgear, door openings shall have resilient compression gasketing to prevent water from entering the enclosure. Gasket seals shall be provided at the top and side edges of adjoining bays to prevent water entry between the double walls.
8. For outdoor switchgear, cover the top and both sides of bus openings between bays with channel gasketing as an additional protection against entrance of water.
9. Outdoor switchgear roofs shall be weather-sealed in place with a suitable sealant.
10. For outdoor switchgear, provide space heaters with sheaths of high-temperature chrome steel to maintain air circulation inside the enclosure. There shall be a space heater in each bay. Heater circuits shall be have low-voltage breakers and thermostats.
11. Provide safety grounding cables per switch.

Delivery, Storage and Handling

1. Package and ship breakers and accessories separately from the switchgear structures.

2. Equip switchgear to be handled by crane. Where installation by crane is not possible, switchgear shall be capable of being moved on rollers or skids. Jacking into place shall not damage the equipment.

G. Medium Voltage Wire, Cables and Terminations

Basis of Design

This section applies to the design and installation relating to wire and cable systems and terminations.

For the MV Wire, Cable and Terminations Standard Specifications click here.

Design Criteria

Medium Voltage Wire and Cable

See SD drawings.

Submittals

1. For medium voltage systems, refer to attached standard specifications, MV Wire, Cable and Terminations.

Products, Material and Equipment

Medium Voltage Wire and Cable

See Preferred Vendors & Products table

Installation, Fabrication and Construction

Medium Voltage Wire and Cable

1. See Preferred Vendors & Products table
2. Medium voltage cable splices and connections are often placed in tunnels and manholes open to non-electrical workers; thus splices shall be provided with protective covers and junction boxes with protective cages. The Consultant shall investigate and work with Engineering Services in designing appropriate worker protection barriers.
3. Conduits for medium voltage installations are rigid steel in buildings and street crossings; schedule 40 PVC in direct buried or concrete encased applications; and cable tray in tunnels. Medium voltage cable shall not be direct buried.
4. Size cable junction boxes to allow future expansion of the cable system.

MV WIRE, CABLE AND TERMINATIONS – STANDARD SPECS

STANDARD SPECIFICATIONS

This standard specification is intended to be integrated into the project specifications. The Consultant shall write the specifications to meet the project requirements in consultation with the Owner.

PART 1 – GENERAL

1.01 DESCRIPTION

A. Purpose

1. This section covers medium voltage (MV) cable and terminations for use in the University's primary and secondary power distribution systems.

1.02 WORK SCOPE

A. A site walk needs to be scheduled with the Electric Utility Manager to define a project's work scope.
B. Sections of the MV armored cable have reached the end of life and needs replacement.
C. Link boxes are being replaced with dead break elbows mounted on a junction box or cable hangers depending on safe working clearances.

1.03 QUALIFICATIONS

A. Approved manufacturers

1. Medium voltage 5 and 15kV wire and cables

a. 5 and 15kV single conductor: Pirelli, Aetna, and Okonite
b. 5 and 15kV armored cable: Pirelli, Aetna, and Okonite

i. Service Wire for short lengths of interlock armored cable (< 500 feet)

c. All other manufacturers shall be approved during the design prior to bidding.

1.04 RELATED SECTIONS

A. The work under this section is subject to requirements of the Contract Documents, including the General Conditions, Supplemental Conditions, and sections under Division 1 General Requirements.
B. Electrical Identification
C. Inspection, Calibration and Testing

1.05 REFERENCES

A. Applicable codes, standards, and references codes, regulations and standards

1. National Electrical Testing Association – NETA
2. National Fire Protection Association – NFPA
3. National Electrical Code - NEC
4. AEIC CS6-96 (ethylene propylene rubber)
5. ICEA S-93-639 (ethylene propylene rubber)
6. IEEE STD 400-1991 (DC Testing)
7. IEEE STD 48
8. UL 1072 for physical requirements for the armor
9. UL 1008 – Automatic Transfer Switches
10. State and local codes and ordinances

1.06 COORDINATION

A. Coordinate Operations and Maintenance training times with the University.

1.07 SUBMITTALS

A. General

1. Submittals shall be in accordance with Conditions of the Contract and Division 01 Specification Sections.
2. Submit detailed maintenance manuals and drawings, which include catalog information indicating the complete electrical and mechanical characteristics.
3. Submit current manufacturer's AEIC pre-qualification data.
4. Submit dimensioned cross-sectional drawings (manufacturer's data sheets are acceptable).
5. Submit finished cable tests – Manufacturer's Certified Test Reports showing compliance with ICEA S-68-516, Part 3, and UL 1072 for physical requirements of the armor and all AEIC final tests, including x-y plots of corona discharge for the actual cable furnished.
6. Submit pulling calculations and plan for each medium voltage cable length.
7. Submit data sheet on crimping tools to be used.
8. Submit for approval the résumés of the medium voltage cable splicers. Qualifications should include certification, recent work history on similar splice type and knowledge of the "Safety Standards for Electrical Workers" (WAC 296-45).

1.08 OPERATIONS AND MAINTENANCE (O&M) MANUALS

A. Operations and Maintenance Manuals shall be in accordance with Conditions of the Contract and Division 01 Specification Sections.
B. Operations and Maintenance Manuals shall include but not be limited to pull calculations and catalog information indicating complete electrical and mechanical characteristics.
C. Manufacturer's Certified Test Reports
D. Manufacturer's AEIC Pre-qualification Data

1.09 MEETINGS

A. Pre-installation conference

1. The Contractor shall request a pre-installation conference with the University's Engineering Services and University's Physical Plant High Voltage Shop for projects with medium and high voltage work.

B. Attend meetings with the Owner and/or Owner's Representative as required to resolve any installation or functional problems.

C. Within 1 month after "Notice to Proceed," schedule a meeting with UW Representatives to review electrical identification requirements.

PART 2 – PRODUCTS

2.01 GENERAL

A. These cable and terminations specifications are in accord with the University's policy to construct permanent installations with long life, coupled with maximum reliability and safety. It is intended that the best available materials be used and new and better materials adopted as they become available and are approved by the University.

2.02 MEDIUM VOLTAGE WIRE AND CABLE

A. The following shall apply to both 5kV and 15kV medium voltage power conductors used as single conductors or assembled into 3/c armored cable:

1. Single conductors

a. Conductors: Class B stranded, concentric, soft or annealed copper per Part 2 of ICEA S-68-516

b. Strand screen: Extruded semi-conducting thermosetting compound applied over the conductor. The material shall be compatible with the conductor metal, shall be uniformly and firmly bonded to the overlying insulation, and be free of stripping from the conductor.

c. Insulation: High quality heat, moisture, ozone and corona resistant Ethylene Propylene Rubber (EPR) compound

i. The insulation shall contrast in color with the strand screen and insulation shield per AEIC CS 6.

ii. Insulation level shall be 133% (115 mils for 5KV, 220 mils for 15KV).

iii. The minimum thickness of the insulation at any point shall not be less than 90% of the specified nominal thickness.

iv. The insulation shall contain no more than 2% polyethylene.

d. Insulation shield: Extruded semi-conducting thermosetting compound applied directly over the insulation. The material shall be compatible with the insulation and overlying metallic shield. The insulation shield shall be clean and free of stripping from the insulation and comply with Paragraph D.1 of AEIC CS 6.

e. Manufacturing process: The strand screen, insulation, and insulation shield shall be applied with a triple-tandem process providing a virtual corona-free core. The EPR insulation system shall not be exposed to the atmosphere during manufacture.
f. Metallic shield and individual jacket: .005 inch thickness of copper tape helically applied over the insulation shield material with a 20% overlap, covered with an extruded PVC outer jacket meeting the requirements of ICEA S-68-516 Paragraph 4.4.10.
g. Identification: The following information shall be surface-printed on the overall jacket: Manufacturer's name, cable size, cable type, year of manufacture and voltage rating.

2. Armored cable
    a. Single conductors: Per the section above. **(Note: Individual PVC jacket shall be required for each single conductor)**.
    b. Grounding conductors: Bare copper, stranded in accordance with ICEA S-68-516, Part 2. Minimum size shall be in accordance with UL 1072, Table 11A. **(Note to designer: Provide a larger size, if required, to handle calculated fault current.)**

    IMPORTANT: In the University of Washington primary distribution system the size of main primary feeders are 500 KCM. In instances where #2/0 cable is tapped from 500 KCM cable, to subfeed a facility or load, provide ground conductors in #2/0 cable equal to the ground conductor of 500KCM cable. Ground conductors shall be factory installed with the phase conductors and shall be an integral component of the cable. This is not an industry standard and shall be clearly indicated in the design documents. Supplemental grounding conductor external to the interlock armored cable is not acceptable by the AHJ.

    c. Filler material: Non-hygroscopic material, fine fiber, completely filling center and peripheral interstices
    d. Binder tape: Applied over assembly to provide a solid core
    e. Armor: Galvanized steel or aluminum, interlocked armor in accordance with ICEA S-68-516, Part 4 and UL 1072, Part 25.11
    f. Overall jacket: Polyvinyl Chloride (PVC) in accordance with ICEA S-68-516 paragraph 4.4.10. Industry standard color by voltage class (15kV cable – red; 5kV cable – yellow).
    g. Identification: The following information shall be surface printed on the overall jacket: Manufacturer's name, cable size, cable type, year of manufacture and voltage rating.
    h. Listings: Finished cable shall be UL listed as Type MC, MV-90 and "For CT USE."
    i. Color for outer jacket shall be consistent with industry standards.

3. Cable rejection

    a. Cable shall be subject to inspection by the University at delivery and installation and subject to rejection for shipping and/or installation damage including, but not limited to, jacket penetration, armor denting, or other indications that cable integrity has been compromised.

b. Hi-pot and Megger testing will not be the sole determining factor in the Owner accepting or rejecting damaged cable.

2.03 SPLICES AND TERMINATIONS

A. Medium voltage

1. Medium voltage connections and terminations (armored cable and single conductor) - Long barrel, 2-hole hydraulic crimp lugs, with Raychem "HVT" or 3M "Quick Term" series 5600 termination kits
2. Existing link box are to be replaced with MV junction boxes with deadbreak elbows. Grounding drain wires to be long enough that elbows can be removed and replaced without resplicing the connection.
3. Splices other than cold shrink are to be housed in a listed enclosure: OZ Gedney Series SPKJR, G&W #E74 or Adalet 3AS manufactured by PLM, with fittings to suit cable.

IMPORTANT: Specifier to add Exact Requirements for Cable

4. Fireproof any cables outside of cable tray with a non-asbestos liners.
5. Method of crimp termination for #8 awg and larger shall be performed with correctly sized hexacentric die only.

   a. Approved manufacturers: 3M, Elastimold; all other manufacturers shall be approved prior to bidding.

PART 3 – EXECUTION

3.01 REQUIREMENTS

A. General installation

1. Identification

   a. Reference section Electrical - Wire, Cable and Terminations

2. Qualification and Training

   a. Medium voltage cable work shall be performed by qualified and experienced personnel. Cable manufacturer's representative shall provide training and shall oversee the rigging, pulling, installation, and termination of medium voltage cable.

3. Installation

   a. The installation of cables shall be done with care to avoid damage.

      i. Cables showing damage after installation shall be replaced.
      ii. Rollers and spools shall be used in adequate numbers for pulling in cables.

iii. The tension limitations, side wall pressure, and minimum bending radius as given by the cable manufacturer shall be observed.

b. Cable pulling

i. In no case will strands be removed to attach pulling eyes.
ii. Tension is limited to 1000 lbs. using basket grips.
iii. Lubrication shall be as approved for the insulation and raceway material.
iv. Prior to pulling, calculations of pulling tension and side wall pressure shall be submitted.
v. A dynamometer shall be used and tension recorded for all MV pulls.
vi. Use no mechanical means for pulling #8 and smaller AWG conductors.

c. Cable pulling setups and operations shall be witnessed by the University Physical Plant High Voltage Shop and Engineering Services.
d. Interlocked armor cable shall be pulled only when both the armor and conductors are gripped. Remove cable similarly.
e. All cable that leaves a tray shall be taped/wrapped with Scotch 77, MAC AP30, or Quelcor "Quelpyre" fireproofing tape.

B. Medium voltage cable terminations

1. Phase mark each conductor, secure conductors adequately and observe cable bend radius limitations. University will identify the West Receiving Station phase rotation convention.
2. System Phase Sequence is C-B-A.
3. MV switch phase terminations shall be A-B-C left to right when facing the front of the switch.
4. Junction box phase terminations are A-B-C left to right.
5. Standard link box phase terminations are A-B-C left to right, top to bottom, front to back. Some existing link box phase terminations are not standard, especially on the 2.4kV normal and emergency power system.
6. The Physical Plant Department High Voltage Shop will identify the phase designation of the existing primary distribution system conductors to which the Contractor is to make a connection.

a. They will also check the Contractor's work to ensure the accuracy of the connections.
b. The Contractor shall arrange with the University for the times when their services will be required, and under no circumstances shall the Contractor connect to the existing system without their knowledge.
c. The proper connection of the wires and cables to other systems as specified is entirely the responsibility of the Contractor.
d. In the event the connections cannot be made as specified, the Contractor shall make the necessary corrections at his own expense.

7. Install cable terminations per manufacturer's recommendations.

8. Medium voltage cable splices shall be made only when absolutely necessary. When necessary, splices shall be made only by personnel qualified and experienced in this type of work.
9. Each high voltage splice or connection shall be permanently labeled with the following information:
    a. Contract or project designation
    b. Contractor doing work
    c. Name of splicer and date
10. Do not score the conductor when stripping insulation and always pare or pencil when using a blade. Use of a stripping tool is preferable.
11. All terminations shall be secure and tightened in accordance with the manufacturer's recommendations.

C. Mounting and electrical connections

1. In accordance with manufacturer's installation instructions.
2. Coordinate remote control and annunciation with the University representatives.

D. Training

1. Provide operation and maintenance training for two 2-hour sessions of on-site training for a total of 6 maintenance personnel.
2. Include troubleshooting, repair and maintenance manuals for each participant.

E. Testing

1. Provide factory field startup and testing services to assist the ETC (Electrical Testing Contractor) per Section Electrical - Inspection, Calibration and Testing.

H. MV Load Interrupter Switches

Basis of Design

This section applies to the design and installation relating to load interrupters (switches).

Design Criteria

1. 13.8kV equipment shall be 15kV class; 2.4kV and 4.16kV equipment shall be 5kV class.
2. Space for metering CT's and PT's may be required in the switch enclosures.
3. Provide barriers to meet Washington State rules. Air break switches require an insulated barrier between line and load contacts when the switch is open to comply with State Code requirements.
4. Equipment switches shall be fused for coordination with the rest of the University's power distribution system. Refer to the University's short circuit studies for design fault duties.
5. Switches shall be able to be configured and operated according to UW High Voltage Shop operation procedures for closed transition switching. In a primary-select configuration, allow switching operations between two feeders so that one feeder can be isolated, de-energized, and "cleared" for shutdown while the other feeder continuously serves building loads without interruption. Note that in this configuration the load side of both incoming feeder switches is always energized when either switch is "opened".
6. Switch line-ups with the "primary select" configuration" shall be bus type construction that can accommodate addition of future switches by extension of existing busses. Switch enclosures shall be equipped with removable plates to allow extension of the busses on both sides ends of the lineup. New switches shall match the manufacturer and type of existing switch line-ups they are being added to. Additional spaces and enclosures may be required to accommodate bending radius requirements of feeder cables.
7. When sizing vaults or rooms for primary switch line-ups always design space for the addition of future switches. In addition to future building switches, also allow space for the installation of a switch for construction power. Space for future switches shall be designed and noted in the design documents.
8. Where expansion space is available, design switches for future extensions to additional equipment bays on both ends of the lineup.
9. Do not use oil and gas insulated switches. (Exception: Pad-mount transformers with integrally equipped switches may be oil filled.)

Submittals

1. Equipment catalog cuts
2. Dimensioned installation drawings
3. Certified test reports of full load, load interrupt and fault current and close and latch ratings

Products, Materials and Equipment

1. Approved manufacturers: S&C Electric, no exceptions.

2. Interrupter switches shall have a one-time or two-time duty-cycle fault-closing rating equal to or exceeding the short-circuit rating of the switchgear. These ratings define the ability to close the interrupter switch either alone (unfused) or in combination with the appropriate fuse, once or twice (as applicable), against a three-phase fault with asymmetrical current in at least one phase equal to the rated value, with the switch remaining operable and able to carry and interrupt rated current. Tests substantiating these ratings shall be performed at maximum voltage. Certified test abstracts establishing such ratings shall be furnished upon request.
3. Interrupter switches intended for manual operation shall be operated by means of an externally operable, non-removable handle. The handle shall have provisions for padlocking in both the open and closed positions. Interrupter switches intended for power operation shall be operated by means of a switch operator expressly designed to be compatible with the interrupter switch.
4. Interrupter switches shall utilize a quick-make quick-break mechanism installed by the switch manufacturer, which shall swiftly and positively open and close the interrupter switch independent of the switch-handle or switch operator operating speed.
5. For manually operated interrupter switches, and for interrupter switches operated by direct motor drive switch operators, the quick-make quick-break mechanism shall be integrally mounted to the switch frame.
6. Interrupter switches shall be completely assembled and adjusted by the switch manufacturer on a single rigid mounting frame. The frame shall be of welded steel construction such that the frame intercepts the leakage path which parallels the open gap of the interrupter switch, to positively isolate the load circuit when the interrupter switch is in the open position.
7. Provide interrupter switches with a single blade per phase for circuit closing including fault closing, continuous current carrying, and circuit interrupting. Spring-loaded auxiliary blades shall not be permitted.
8. Interrupter switches shall have a readily visible open gap when in the open position to allow positive verification of switch position.
9. Interrupter switches shall be hinged at the bottom of the switch blade to allow insertion and removal of a full isolating barrier in the open gap when the switch is opened with a hotstick.
10. Provide reverse cable entrance/exit on all bays.
11. Provide copper main and ground bus as well as copper terminals on switches and fuses.
12. Provide isolating barrier per switch compartment. The interrupter switch housing shall have provisions guides/tracks/brackets to facilitate installation and hold the barrier in place (when installed). Barrier shall be of NEMA GPO3-grade fiberglass reinforced polyester. WARNING: REQUIREMENT FOR BARRIER IS A NON-STANDARD COMPONENT.
13. Provide grounding stirrups in the line and load compartments such that, with the barrier installed, grounding can be achieved without entering an energized compartment.
14. Grounding jumpers are to be provided with clear insulation; Part No. 3611-215 for Salisbury “ball-type” studs and Part No. 3611-479 for S&C standard studs.
15. Salisbury “ball-type” ground studs are required on switch terminals of “switch-only” entrance bays. Standard S&C ground studs are required on terminals of “fused-switch” feeder bays.
16. All grounding landing pads shall have a “Chance” stud ball.

17. Pads for switch line-ups with the “primary select” configuration shall have space for additional switches to be added in the future. Where space is limited and allowing space for future switches is difficult, contact Engineering Services for resolution.
18. “Kirk-Key” system is not allowed unless specifically requested by the Engineering Services and Campus Utilities and Operations.
19. All switches installed in exterior areas, utility tunnels, vaults, and other areas exposed to steam condensation, corrosion, and moisture, shall be NEMA 3R exterior type construction. NEMA 3R switches have larger space requirements and may be mounted on a stand-off frame.
20. Approved manufacturer: S & C.
21. Load side of switch shall be on the bottom.
22. If equipped with lightning arresters, they shall be located on the load side of the switch.
23. Pad Mount – Manually operated, elbow connected, compartmentalized & fused. May be integral with a transformer.
24. Provide two sets of NO and NC contacts for remote monitoring the switch position. Wire the switches out to a terminal strip (typically located near the top of the bay) that is accessible for safe access when the switch is energized.

Typical primary select interrupter switch and isolation barrier configurations:

16K – Figure 1
Primary Select 3-Bay Switching

16K – Figure 2
Isolation Barrier in Storage Position

16K – Figure 3
Isolation Barrier Being Inserted

16K – Figure 4
Barrier Isolating Switch

Fuses

1. Solid-material power fuses shall be of the solid-material type and shall utilize refill-unit-and-holder or fuse-unit-and-end-fitting construction. The refill unit or fuse unit shall be readily replaceable.
2. For switchgear rated up through 270 MVA at 4.16 kV and 600 MVA at 13.8 kV, mountings for solid-material power fuses shall be disconnect style. Non-disconnect style mountings for power fuses shall be used only where higher ratings are required.
3. Solid-material power fuses shall be equipped with a blown-fuse indicator that shall provide visible evidence of fuse operation while installed in the fuse mounting.
4. Solid-material power fuses in feeder bays shall be equipped with grounding provisions on the load side of each fuse and on the enclosure ground bus.
5. SM-5S fuses are required for 13.8kV equipment. SM-5S fuses are required for 2.4kV and 4.16kV equipment.
6. Fuse ratings for 13.8kV equipment is to be provided per the table below.

OVERCURRENT DEVICE RATINGS		
Transformer size (KVA)	Fuse Rating (A)	Main Breaker Pick up (A)
300	25	-
500	40	800
750	65	1200
1000	80	1800
1500	125	2400
2000	150	3200
2500	200	4400

Installation, Fabrication and Construction

1. Switches may be installed indoors or outdoors in non-secure areas.
2. A category “A” enclosure is to be provided for equipment installed on non-secured locations.
3. Provide features and requirements for enclosures similar to medium voltage switchgear requirements.
4. Each bay is to be furnished with laminated plastic nameplates.
5. Indoor enclosures shall be drip-proof. All enclosures shall be of compact height: 90” for indoor installations and 93” for outdoor installations.
6. For outdoor installations, provide features and requirements for enclosure ventilation, lifting eyes, gasketing and sealing, and space heaters similar to medium voltage switchgear requirements. A thermostat and low-voltage circuit breaker is to be provided in the heater circuit on outdoor equipment,
7. Load connections may be direct (transformer throat) or via cable. Note: Phase rotation is a concern at transformer terminals and may require transition space.

8. Campus phase sequence is C-B-A. Cable termination positions in switches shall be A-B-C left to right, top to bottom, or front to back when viewed from the front of the switch.

DRY-TYPE, MEDIUM-VOLTAGE TRANSFORMERS – STANDARD SPECS

STANDARD SPECIFICATIONS

This standard specification is intended to be integrated into the project specifications. The Consultant shall write the specifications to meet the project needs in consultation with the Owner and in accordance with the attached design information section.

PART 1 – GENERAL

1.01 BASIS OF DESIGN

A. Specification covers dry type transformers, with primary voltage above 600 V, For use as shown on plans

1.02 REFERENCE STANDARDS

A. ANSI C57.12.50- Requirements for Dry-Type Distribution Transformers, 1-500 kVA 1-phase and 15-500 kVA 3-phase, with high voltage 601 - 34,500 V, low voltage 120-1000 V
B. ANSI C57.12.51 - Dry-Type Power Transformers 501 kVA and Larger, 3-Phase with High-Voltage 601 to 34 500 V, Low-Voltage 208Y/120 to 4160 V, Requirements for Ventilated
C. ANSI C57.12.55 - Dry-Type Transformers in Unit Installations, Including Unit Substations - Conformance Standard
D. ANSI C57.12.70 - Terminal Markings and Connections for Distribution and Power Transformers
E. IEEE C57.12.01 - General Requirements for Dry-Type Distribution and Power Transformers Including Those with Solid Cast and/or Resin Encapsulated Windings
F. NEMA 5T20- Dry Type Transformers for General Applications
G. UL 1561 - Dry Type General Purpose and Power Transformers

1.03 SUBMITTALS

A. Submit Shop Drawings for equipment provided under this Section.
B. Acoustical Sound and Vibration Test Data
    1. Acoustical sound and vibration test data on manufactured unit.
        a. Test data sheets shall be submitted for review and approval by Owner and Architect/Engineer prior to shipment to job site.
C. Current Manufacturer's AEIC pre-qualification

PART 2 – PRODUCTS

2.01 MANUFACTURERS

A. Acceptable Manufacturers: ABB, General Electric, Square D, Siemens, Eaton
B. Approved equal.

2.02 RATINGS AND STANDARDS COMPLIANCE

A. Show ratings and Impedance of transformer on drawings. Where impedance is not specified elsewhere provide 7% impedance for transformers in three transformer networks and 5.75% for non-networked transformers.
B. Ventilated dry type transformers shall comply with ANSI 57.12.51

2.03 CONSTRUCTION

A. Refer to drawings for cooling transformer type.
B. Transformer shall be cooled by natural air and forced air convection (AA/FA).

1. Units shall include fans to increase kVA rating by 33%
2. Fan motors shall be 120 V with individual fusing.
3. Temperature monitor and fan control unit includes:

    a. Temperature monitor with digital readout.
    b. GREEN- power on, YELLOW- fan on, RED- high temperature indicating lights.
    c. Audible high temperature alarm with alarm silence pushbutton.
    d. Maximum temperature memory with read and reset switch.
    e. Auto/manual fan control switch.
    f. System test switch.
    g. Auxiliary alarm contact for remote control and temperature monitoring.
    h. Acceptable manufacturer: Temptrol

4. Temperature sensing in each coil.
5. Sequence of Operation

    a. Transformer operating below natural air convection cooling (M) rating.
    b. GREEN light is activated
    c. Temperature rises to above natural air convection cooling (M) rating
    d. Relay is energized, fans and YELLOW light activate.
    e. Temperature rises to higher set point, relay energizes and audible alarm, RED light, and circuit for remote alarms activates.

6. Control power shall be provided from control power transformer self-contained in equipment.
7. Emergency Unit Substation transformers shall be pre-wired for future fan cooling, including RTD's or thermocouples embedded in the windings for temperature control.

2.04 INSULATION TYPE VPI

A. Electrical Insulation

1. Class H Insulation system shall be rated 22o•c.
2. Temperature rise based on a 3o•c ambient with a maximum 4o•c.
3. Insulation shall be inorganic materials such as porcelain, glass fiber, electrical grade glass polyester, or Nomex.
4. Coil assembly shall be Vacuum Pressure Impregnated (VPI) polyester.
5. Transformer shall be:

   a. Designed for temperature rise of 15o•c and shall be capable of operating at 33% above base nameplate kVA capacity continuously.
   b. Designed to meet sound level standards for dry-type transformers.

6. Basic Impulse Insulation Level: 95kV for 15kV; 60 BIL for 5Kv (emergency system); 30kV for 600V and below.

2.05 ENERGY EFFICIENCY

A. Minimum 98% efficiency or as required by Department of Energy minimum transformer efficiency requirements (CFR 43192 & DOE 78FR23335), whichever is greater.

2.06 CORE AND COIL

A. Coil:

1. Windings shall be copper.

B. Core:

1. Constructed of high grade, grain oriented, non-aging silicon steel.

2.07 TAPS

A. Taps:

1. Rigidly support
2. Mark for connections
3. Accessible from front or back by panel removal
4. Four 2 Y.% full capacity taps; two above and two below rated voltage.

2.08 ENCLOSURES

A. Transformer enclosure shall:

1. Be constructed of 12 ga sheet steel.
2. Be equipped with removable panels for access to core and coils.
3. Include front and rear panels with ventilated grills.
4. Include rubber isolation pads to isolate core from case. There shall be no metal-to-metal contact.
5. Base suitable for skidding in all directions.

B. Finish:

1. Transformer enclosure and rails shall be finished with manufacturer's standard finish.
2. Outdoor transformers shall have outdoor paint finish.

C. Ventilation Openings - Louvered or fine mesh screened. Punched holes are unacceptable to guard against insertion of foreign objects.

2.09 NAMEPLATE

A. Nameplates shall be:

1. Secured to transformer enclosure with screws.
2. Diagrammatic nameplate listing all information as required by NEMA standards.

B. Transformer:

1. Transformer shall have nameplate with:

    a. Manufacturer's name and drawing number.
    b. Transformer identification tag as indicated on drawings
    c. Electrical connection diagram
    d. Primary and secondary voltage rating
    e. kVA rating
    f. Basic Impulse Level

C. Doors:

1. Provide external doors and hinged bolted panels with "Caution - High Voltage - Keep Out" signs.

D. Submit identification to Owner/Architect/Engineer for approval.

2.10 ACCESSORIES

A. Transformer shall include:

1. Provisions for lifting and jacking
2. Removable panel for access for de-energized tap changing
3. Two ground pads using Salisbury ground ball studs.
4. A continuous 1/4" x 2" ground bus for connection to adjacent compartment's switchgear.

2.11 TERMINAL COMPARTMENTS

A. Transformer shall include HV terminal compartment and LV terminal compartment.

1. Air filled primary terminal chamber adequately sized stress cone termination of 3 to 6 single conductors as indicated.

B. Connections between:

1. Primary device and transformer shall be bus.
2. Transformer and secondary shall be Bus.

3. Connections between the transformer and the switchgear shall be provided by the switchgear manufacturer.

C. Secondary neutral connection shall be brought out for bonding to ground bar.

1. Provide fully insulated secondary neutral bushing (externally groundable) to permit the use at a neutral conductor or CT or GF sensing.

D. Provide removable link between neutral point and ground bar.

E. Distribution class surge arresters, rated at 15kV, located in HV terminal chamber.

F. Terminal markings shall be provided on the transformer terminals and shall clearly identify each terminal when doors or covers are opened.

1. Transformers will have high voltage (primary) terminal markings:

a. "H1" to "N' Phase
b. "H2" to "C" Phase
c. "H3" to "B" Phase

2. Low voltage switchgear normally connected to the building power service transformers will be constructed in accordance with industry standards and will have their buses identified "1", "2", "3", "N". Transformers will have low voltage (secondary) terminal markings "X1", "X2", "X3", "XO" from left to right or top to bottom when facing the low voltage terminals and the switchgear shall be as follows:

a. "X1" to "1" (BUS)
b. "X2" to "2" (BUS)
c. "X3" to "3" (BUS)

3. Noted: transformer connections as indicated above results in a rotation sequence at the low voltage switchgear of "1", "2", "3".

2.12 QUALITY ASSURANCE

A. Transformers to be of the highest quality manufactured by a firm that has manufactured such apparatus for at least 25 years.

2.13 VIBRATION ISOLATION

A. Mounting type - Unit DNP (Double Neoprene Pad): Neoprene pad isolators shall be formed by two layers of 1/4-inch to 5/6-inch thick ribbed or waffled neoprene, separated by a stainless steel or aluminum plates. These layers shall be permanently adhered together.

1. Neoprene shall be 40 to 50 durometer. The pads shall be sized so that they will be loaded within the manufacturer's recommended range.
2. Provide steel top plate equal to the size of the pad. This is provided to transfer the weight of the supported unit to the pads.
3. Acceptable manufacturers: Amber/Booth

a. Korfund Dynamics
b. Mason Industries

c. Peabody Noise Control
d. Vibration Mountings Control
e. Kinetics Noise Control

B. Provide vibration control devices, materials and related items. Perform all work as specified in this section to provide complete vibration isolation systems in proper working order.

1. Coordinate the size, location, and special requirements of vibration isolation equipment and systems with other trades. Coordinate plan dimensions with size of housekeeping pads.
2. Size isolators to meet the specified loading requirements.
3. Should equipment cause excessive noise or vibrations, the Contractor shall be responsible for remedial work required reducing noise and vibration levels. "Excessive" is defined as exceeding the manufacturer's specifications for the unit in question.
4. Upon completion of the work, the Owner's Representative shall inspect the installation and shall inform the installing contractor of any further work that must be completed. Make all adjustments as directed. This work shall be done before vibration isolation systems are accepted.

I. Power System Studies

Basis of Design

This section applies to the requirements for the performance of power system studies by both the Design Engineer and the Contractor.

For this section's Standard Specifications click here.

Background Information

1. Engineering Services Facilities Information Library (FIL) contains historical Short Circuit and Coordination Studies for reference. Fault calculations within FIL are finite and are not calculated to all extremes of the primary distribution system.
2. For other campus sites, contact the local utility to establish the initial available fault current.

Design Criteria

1. The Consultant is responsible for providing design level short circuit calculations to ensure that the design and estimates are based on the correct sized equipment. For the Seattle campus where the studies are not available in FIL, the Engineer of Record is to use an infinite bus calculation used on primary winding of the utility service transformer.
2. The Contractor required to perform a Short Circuit and Coordination Study once the actual equipment being provided has been determined. The Contractor shall utilize the study results as follows:
    a. Verify that all equipment being provided is correctly rated.
    b. Calibrate and test the equipment per the settings provided by the Coordination Study.
    c. For substations with spot or distributed network protection, provide calculations and settings to configure the network protection relays.
    d. For equipment that has a maintenance feature, include that calculation.

Construction Submittals

Refer to the Short Circuit & Coordination Studies standard specifications.

Products, Materials and Equipment

Refer to the Short Circuit & Coordination Studies standard specifications.

Installation, Fabrication and Construction

Refer to the Short Circuit & Coordination Studies standard specifications.

SHORT CIRCUIT AND COORDINATION STUDIES – STANDARD SPECS

STANDARD SPECIFICATIONS

This standard specification is intended to be integrated into the project specifications. The Consultant shall write the specifications to meet the project needs in consultation with the owner. The requirements in the "Schedule" section here will impact other specification sections. The designer shall modify these specification sections and edit the "Related Sections" below accordingly.

PART 1 – GENERAL

1.01 DESCRIPTION

A. Purpose

1. The purpose of these studies is to assure all electrical equipment is correctly applied within industry and manufacturer's ratings. This effort should minimize the damage and limit outages caused by any electrical failure and will assure proper personnel protection. These studies are required from the Contractor once the actual equipment being provided has been determined.

B. General

1. The Power System Protective Device Studies shall consist of one-line diagram(s), short circuit and coordination studies prepared for the specific electrical equipment, overcurrent devices, utilization equipment (NEC defined) and feeder lengths involved with this project. The study shall also include Arc Flash Analysis and Hazard/Risk categories for distribution points such as transformers, switchboards, panelboards, MCCs, VFDs, disconnect switches, etc.
2. Furnish labor, material and coordination with Engineering Services to accomplish the studies as specified in this section.

1.02 QUALIFICATIONS

A. Studies to be performed by or under the supervision, review, and approval of a professional Electrical Engineer holding a current license from the State of Washington.
B. Preapproved, subject to the Licensed PE requirements and the software analysis products specified in this section:

1. Eaton Technical Services
2. Electrotest, Inc.
3. Power Systems Engineering
4. Siemens Technical Services

5. Western Electric, Inc.

1.03 RELATED SECTIONS

A. The work under this section is subject to requirements of the Contract Documents including the General Conditions, Supplemental Conditions, and sections under Division 1 General Requirements.
B. Inspection, calibration & testing section

Note to the designer: Add the related sections' references according to the requirements of the schedule section.

1.04 REFERENCES

A. Applicable codes, standards, and references:
   1. National Electrical Code – NEC
   2. Institute of Electrical and Electronic Engineers – IEEE
   3. American National Standards Institute – ANSI
   4. State and local codes and ordinances

1.05 COORDINATION

A. Coordinate with the electrical contractor and equipment vendors, as required, to determine the actual equipment to be furnished.

1.06 SUBMITTALS

A. General

   1. Submittals shall be in accordance with Conditions of the Contract and Division 01 Specification Sections.
   2. The studies shall be submitted stamped by a professional Electrical Engineer holding a current license from the State of Washington.

1.07 OPERATIONS AND MAINTENANCE (O&M) MANUALS

A. Operations and Maintenance Manuals shall be in accordance with Conditions of the Contract and Division 01 Specification Sections.

1.08 SCHEDULE

A. One purpose of these studies is to verify equipment ratings. Submit preliminary Short Circuit and Coordination Studies with the submittals for the protective devices, panelboards, switchboards and other electrical equipment.

Note to the designer: Coordinate the equipment submittal requirements in the appropriate specifications sections with the requirements noted above.

1.09 MEETINGS

A. Attend meetings with the Owner and/or Owner's Representative as required to explain the results of the studies and to determine any corrective action that is required.

PART 2 – PRODUCTS

2.01 APPROVED SOFTWARE ANALYSIS TOOLS

A. The Short Circuit Study, Coordination Study, and Arc Flash Calculations shall be performed using the SKM Power Tools for Windows (PTW) software package, with no substitution:

B. SKM PTW software package used shall be the latest available releases.

PART 3 – EXECUTION

3.01 REQUIREMENTS

A. Perform Power System Protective Device studies.

B. The Contractor shall be responsible for gathering all field information and data needed for the protective device studies.

3.02 ONE-LINE DIAGRAM

A. Provide a one-line diagram from SKM PTW that shows the schematic wiring of the electrical distribution system. Include all electrical equipment and wiring to be protected by the protective devices installed under this project.

1. Key nodes on the one line diagram shall be identified and referenced in the formal report. The one-line diagram shall include the following specific information:

a. X/R ratios, utility contribution, and short circuit values (asymmetric and symmetric) at the bus of the main switchboard, and all downstream equipment containing overcurrent devices
b. Breaker and fuse ratings
c. Transformer KVA and voltage ratings, percent impedance, X/R ratios, and wiring connections
d. Voltage at each bus
e. Identifications of each bus
f. Conduit material, feeder sizes, and length
g. Calculated short circuit current
h. Arch Flash hazard/risk categories

3.03 SHORT CIRCUIT STUDY

A. Assumptions for Short Circuit Study calculations:

At the West Receiving Station *(Fault Current @ 13,800V)*		
Fault Description	**Amperes**	**X/R**
3-phase fault*	32.4kA	11
L-G fault	2kA (resistance limited)	

** The three-phase fault level is a ½-cycle symmetrical value, which includes motor contribution and operation of all on-site generators. For purposes of calculating short circuits for devices with ½-cycle response, use this value as a steady-state quantity.*

B. The study shall show fault currents available at key points in the system down to a fault current of 7,000A at 480V and 208V.

C. Determine the available 3-phase short circuit and ground fault currents at each bus and piece of equipment. Incorporate the motor contribution in determining the momentary and interrupting ratings of the protective devices.

D. Incorporate pertinent data and the rationale employed in developing the calculations into the introductory remarks of the study.

E. Present the data determined by the short circuit study in a table or report format. Include:

1. Device identification
2. Operating voltage
3. Protective device
4. Device rating
5. Calculated 3-phase short circuit current (asymmetrical and symmetrical), and ground fault current

3.04 COORDINATION STUDY

A. Prepare coordination curves to determine the required settings of protective devices to assure selective coordination.

1. Graphically illustrate, on a log-log scale, that adequate time separation is provided between existing and supplied series devices.
2. Plot the specific time-current characteristics of each protective device in such a manner that all upstream devices will be clearly depicted on one sheet.
3. Utilize original SKM 8½ " x 11" #8511 paper for curve plotting.
4. Derive settings for new protective devices in consideration of existing upstream protective device settings, and optimize system coordination in light of this constraint.
5. Where the upstream device characteristics do not allow reasonable coordination with new equipment, identify the problem and the recommended resolution in a letter to the Project Manager prior to submitting the coordination study.

B. The following specific information shall also be shown on the coordination curves:

1. Device identifications
2. Settings and current transformer ratios for curves
3. ANSI damage curves for each transformer
4. Melting and clearing fuse curves
5. Cable damage curves
6. Transformer inrush points
7. Maximum short-circuit cutoff point
8. Simple one-line diagram for the portion of the distribution system that the coordination curves are depicting

C. Provide the SKM TCC report for each curve, labeled with the applicable curve number.

D. Develop a table to summarize the settings selected for the protective devices. Include in the table the following:

1. Device identification
2. Relay CT ratios, tap, time dial, and instantaneous pickup
3. Circuit breaker sensor rating, long-time, short time, and instantaneous settings, and time bands
4. Fuse rating and type
5. Ground fault pickup and time delay
6. Provide 2 test points for each protective device at levels that are compatible with commonly available test equipment, and the ratings of the protective device. Provide the input level and expected response time for each test point.

E. For substations with spot or distributed network protection provide calculations and settings to configure the network protection relays and prepare a report showing the engineered calculations.

3.05 Arc Flash Analysis and Hazard/Risk Category Calculation per NFPA 70E

A. Perform Arc Flash Analysis and determine Hazard/Risk categories at distribution points per NFPA 70E and show them on one-line diagrams. Include both values for devices that provide a maintenance setting (e.g. RELT).

3.06 COORDINATION, SHORT CIRCUIT STUDY AND ARC FLASH ANALYSIS

A. Analyze the short circuit calculations, and highlight any equipment that is determined to be underrated as specified or not coordinated. Propose approaches to effectively protect the underrated equipment. The Engineer will take major corrective modifications under advisement and the Contractor will be given further instructions.

B. After developing the coordination curves, highlight areas lacking coordination. Present a technical evaluation with a discussion of the logical compromises for best coordination.

C. Provide labels showing Arc Flash Hazard/Risk Categories to be affixed on all distribution points such as transformers, switchboards, MCCs, VFDs, disconnect switches, etc. See section 16AA, Electrical Identification, for a sample “Arc Flash Warning Label”.

D. In addition to the O&M requirements, provide 1 hardcopy and 2 PDF electronic copies of the reports on CD. Also provide a CD of the SKM PTW studies for delivery to University of

Washington Engineering Services. Provide the following immediately upon final completion of the Power Systems Protective Device Studies:

1. Copy of the Project One-line Diagram(s)
2. Coordination Study
3. Short Circuit Study
4. Arc Flash Analysis
5. A cross-reference index of the electronic file names on these disks or CDs to the specific pieces of equipment or systems.

J. Vaults

Basis of Design

This section covers manufactured structures for electric facilities located outside of buildings, including vaults, handholes and pads.

Design Criteria

1. Comply with requirements specified in Seattle Amendment 450-19(a)(1) and WAC 296-46-370 (Boxes and Fittings).
2. Refer to section 16B for additional criteria when designing vaults and raceways for the primary distribution system.
3. Water infiltration is not acceptable. Determine surrounding hydraulic conditions that may cause this to happen (includes entry via existing raceways). Review options.
4. Generally installations need to be H-20 rated.

Submittals

1. Manufacturer's catalog data

Products, Material and Equipment

Manufacturers

1. Utility Vault Co.
2. Renton Concrete Products
3. Fog-Tite
4. Quazite

Installation, Fabrication and Construction

1. Size vault tops to match their vaults.
2. Handhole and vault covers shall be factory-marked "ELECTRIC", "LIGHTING", "FIRE ALARM" as needed.
3. Excavation, bedding material, installation and backfill shall be according to manufacturer's recommendations. Structures equipped with floors or solid bottoms shall be water tight throughout.
4. Equip conduit entering through vault walls with end bells installed flush with the wall and made watertight. Conduits entering through the bottom of handholes & vaults shall comply with WAC 296-46-370.
5. Conduit entry into the vaults shall be located as close as possible to end walls to facilitate cable routing along the walls and optimize interior vault space. Do not locate entry through the center line causing cables to occupy the central space of the vault blocking out space for future connections.

6. Coordinate the vault identifier with Engineering Services. Label the vault in a permanent manner in a visible location, typically on the top of the vault. The Consultant shall specify the method by which the permanent identifier will be added to the vault. This is dependent upon the vault composition (cement, plastic composite, metal etc.)
7. Access hatches and doors for vaults shall be lockable. When equipped with ladders, locks and doors shall be operable from the ladder.
8. Ladders for vaults shall be equipped with an full double rung extension to allow safe access/egress. Single pole type extensions are unstable and are not acceptable.

Building Services

K. Building Services

Basis of Design

This section applies to the design and installation relating to building services.

UW Service Classifications

For design purposes, the University has designated several building power service classifications to accommodate different facility uses and differences in available power service.

1. **CLASS N1** - Spot Network - to be used in the University of Washington Medical Center, Health Sciences, and major research and laboratory facilities.
2. **CLASS N2** - Primary Radial - to be used in most major education, administration, office and support facilities. This class has two subclasses:
   a. **CLASS N2S** - Includes a secondary tie to a second service bus in the same building (double ended substation) or to a separate building.
   b. **CLASS N2P** - Includes a primary selective switching concept. Only to be used if Class N2S is not possible.
3. **CLASS N3** - Secondary Radial - to be used only for small annexes, selected branch campus facilities or other outlying facilities.
4. **CLASS E1** – Hospitals and health care facilities, i.e. University of Washington Medical Center. Designed to meet the requirements of NEC, Article 517. Requires bypass/isolation switches.
5. **CLASS E2** – Health Sciences, and major science research and laboratory facilities. Designed to meet the requirements of NEC, Article 700, 701, 702. Requires bypass/isolation transfer switches.
6. **CLASS E3** – Academic, administration and support facilities. Designed to meet NEC, Article 700, 701, 702. Does not require bypass/isolation transfer switches.
7. **CLASS E4** – Small annex, addition or similar structure. Designed to meet NEC, Article 700, 701, 702. For facilities not connected to the campus ESPS. Does not require bypass/isolation transfer switches.

Design Criteria

1. All services shall have a space at the main electrical service to allow temporary generator hookup to the facility. The space shall be marked as such. Facilities housing critical operations (i.e. Medical, Research, Laboratories, Data Centers) shall have spare breakers in these spaces.
2. All services shall be fully rated. Series rating is not acceptable.

Service Transformer Sizing

1. CLASS N1: Size the transformers serving as one of three transformers in a spot network to carry 50 percent of the "Code" building demand load. Note that the network has to be able

to operate in the “n-1” transformer mode. The increased load capacity from internal fan cooling is to be used only for building spare capacity.

2. CLASS N2P, N2R, E1, E2, E3 and E4: Size the transformer to carry their respective calculated "Code" demand load. The increased load capacity from internal fan cooling is to be used only for building spare capacity. Non-fan cooled transformers shall be size to carry building calculated demand load plus 20% spare transformer capacity.
3. CLASS N2S: Size the transformers serving as one of the two transformers in a distribution system to carry the entire building calculated "Code" demand load. Note that the system has to be able to operate in the “n-1” transformer mode. The increased load capacity from internal fan cooling is to be used for building spare capacity.

Submittals

Provide standard industry submittal requirements.

Products, Materials and Equipment

Refer to the requirements specified in individual Electrical sections.

Installation, Fabrication and Construction

1. UW Class N1 services (spot networks) shall be in vaults with concrete or solid masonry walls and ceilings per NEC 450-C.
2. Locate lock out relays for the spot networks protectors adjacent to each other.

L. Building Power Distribution

Basis of Design

This section applies to the design and installation of building power distribution systems.

Design Criteria

1. This section contains the architectural, structural and mechanical provisions for the building electrical systems. The electrical designer shall coordinate these requirements with the other disciplines to insure these requirements are satisfied.
2. Use attached drawing, Typical Building Power Distribution Riser, as a guide for building power systems.
3. Coordinate with Engineering Services the distribution concepts, including load calculations, calculated fault duties, protective device coordination methods and grounding practices being utilized on the design.

Architectural Provisions

1. Provide separate service entrance electrical rooms for each of the normal and emergency systems in the basement, preferably adjacent to the utility tunnel and on an exterior wall. Equipment access shafts to the outside and walk-in access from the tunnel system shall be provided wherever possible. The design shall take into consideration the possibility of flooding when below grade. Provide emergency power lights with battery back-up to illuminate main service equipment area. Provide at least one phone outlet in main electrical room.
2. Distribution within the building shall be via readily accessible electrical rooms and/or closets. These must be independent from all other types of rooms or closets, i.e., communications, telephone, custodial, audiovisual, etc.
3. As a general guide, provide one floor electrical distribution room to serve each 15,000 to 20,000 square feet.
4. Equipment room and equipment space requirements should exceed minimum NEC requirements and shall be large enough to accommodate the equipment along with space provisions for future equipment. Eventually, panels will become full, requiring the addition of new panels. This is true even for fairly new facilities and is especially prevalent in laboratory and science buildings. These future wall and floor space provisions shall be shown on the design drawings so that space is reserved. Typically, 6-foot hot sticks are used to work on high voltage equipment. Provide adequate working space per NEC, WAC 296-44 and the National Electrical Safety Code.
5. Distribution switchboards, panelboards, and dry transformers over 30 kVA shall be in electrical rooms. Rooms shall be stacked for riser efficiency, and be centrally located to keep feeder lengths to a minimum. Several rooms may be necessary to accommodate the building configuration and system design. Refer to attached drawing, Typical Floor Electrical Room.

6. Closets should be a minimum 2 feet deep by 6 feet wide and equipped with full width double doors opening into a building corridor.
7. Branch panels shall be located in closets located throughout the floor or wing. In laboratories and similar areas, branch panels may be mounted on or in common corridor walls.
8. Transformer ambient noise and EMF emissions from electrical equipment and risers can negatively impact the equipment and function in neighboring spaces. This includes spaces immediately above and below these rooms, closets and risers. Therefore, the space plan shall be reviewed to determine if modifications are required. Use H1 core steel and Unit DNP (Double Neoprene Pad - Neoprene pad isolators formed by two layers of ¼-inch to 5/16-inch thick ribbed or waffled neoprene, separated by a stainless steel or aluminum plate, permanently adhered together, 40 to 50 durometer) for the MV transformers
9. Provide adequately sized access pathways for the repair, maintenance and eventual replacement of the equipment. Equipment access pathways shall be large enough to allow for the removal of transformers, primary switches and other large pieces of equipment. These paths of egress shall be shown on the building drawings. Weights of transformers could exceed floor loading if other than slab-on-grade basement areas are necessary for egress. Make sure that lifting eyes and floor loading are accommodated for in the design.
10. Padmount transformers and switchgear must be accessible by vehicular crane and have sufficient working space per NEC, WAC 296-44 and the National Electrical Safety Code.

Mechanical Provisions

1. Coordinate ventilation requirements in electrical rooms and closets containing transformers or other heat generating sources with mechanical engineer. Convection-type ventilation of the electrical rooms via air/access shafts to the outside has been used in the past at the University. Unfortunately, this allows dirt and debris to get into rooms and equipment, resulting in increased maintenance costs. Therefore, the ventilation shall be supplied and filtered by a ventilation system.
2. Coordinate fire protection requirements in electrical rooms and vaults with the Architect and Mechanical Engineer. The system shall satisfy the code while minimizing the risk of electrocution. Sprinklers in high voltage electrical vaults create extremely hazardous conditions when they discharge, creating an electrocution hazard for workers.
3. Avoid installation of mechanical piping and ductwork in electrical vaults, rooms or closets except where required for operation of the electrical equipment. Piping and ductwork must never be installed directly over any transformer or switchgear. Sprinklers installed to protect the electrical equipment are the only exception. Drain lines from the floors above shall not be piped through the electrical rooms below. It is not allowed to use drip pans as a mitigating means that would allow for the piping to be installed in these areas.

Structural Provisions

1. Provide concrete bases and housekeeping pads for all transformers and equipment, seismically designed with structural connections to the floor slab, and channel or angle iron frames for welded equipment fastening.

2. Provide supports and restraints for Seismic Zone III requirements for all equipment and raceways.
3. Coordinate conduit penetrations in slabs, floors, shear walls, structural members, and other structural elements.

Laboratory Buildings

1. Since laboratory buildings will need constant renovation to keep up with changing technology, they are divided up into lab modules. Each lab (one of more modules) will periodically need to be isolated from the rest of the building to facilitate the renovation without impacting the remainder of the building. Provide circuiting isolation for each lab module. All electrical systems shall be down fed to minimize the number of floor penetrations.
2. If utility corridors can be provided to serve a variety of purposes through laboratory areas, then it would be highly desirable to provide local panelboards, in these utility corridors, dedicated to individual or small groups of laboratories.
3. Lab areas will be designed with the capacity of at least 1 power outlet per 30 square feet. Dedicated circuits will be supplied for all refrigerators, centrifuge and specialty devices. Provide hospital grade receptacles in all research laboratories and procedure rooms in the Health Sciences and other physical sciences.
4. Refer to attached drawing, Laboratory Demand Load, to approximate power required for laboratory areas. Laboratory power systems shall be flexible to allow the anticipated increase in laboratory loads. Local distribution shall be provided based on calculated load. However, more generous conduit sizing, sleeving, space allocated in principal electrical cabinets or closets shall be provided to make it convenient to bring in new feeders to supply additional power for load increases.
5. Dedicated receptacles and isolated ground receptacles are often required for special or sensitive equipment. Extensive use of dedicated receptacles in laboratories can quickly use up all the circuit breakers in the branch circuit panelboard. The Electrical Engineer shall insure that these needs are identified on the room datasheets and that adequate panel space is provided. Define this early in the design process.

Classroom Services See Academic Technologies Audiovisual Systems Integration

Submittals

Provide standard industry submittal requirements.

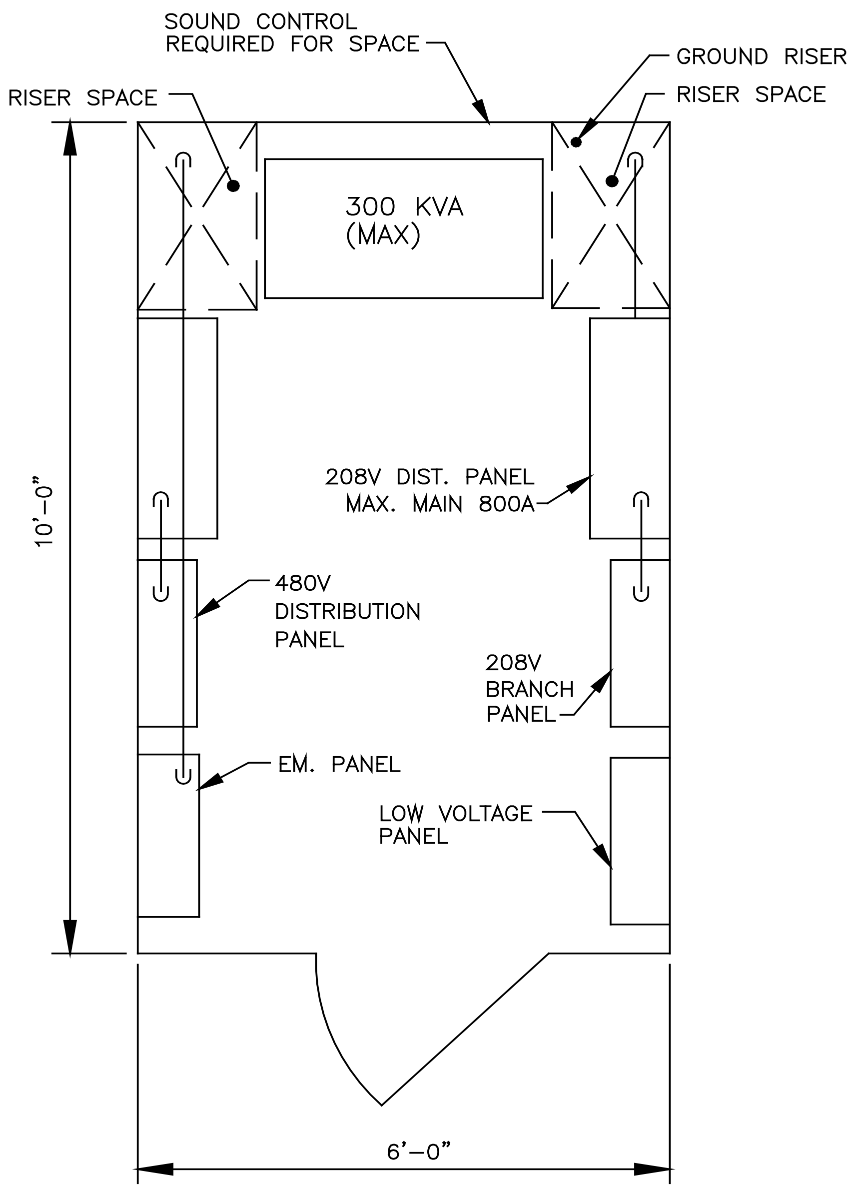
Refer to requirements specified in related sections.

Products, Materials and Equipment

Refer to requirements specified in related sections

Installation, Fabrication and Construction

Refer to requirements specified in related sections



NOTE:
ADDITIONAL ROOMS OR CLOSETS MAY BE REQUIRED ON EACH FLOOR. ADDITIONAL SPACE MAY BE REQUIRED FOR LIGHTING CONTROL PANELS, CRITICAL OR EQUIPMENT BRANCH PANELS, FIRE ALARM PANELS, SUPERVISORY CONTROL PANELS, AND SPACE FOR FUTURE PANEL(S).

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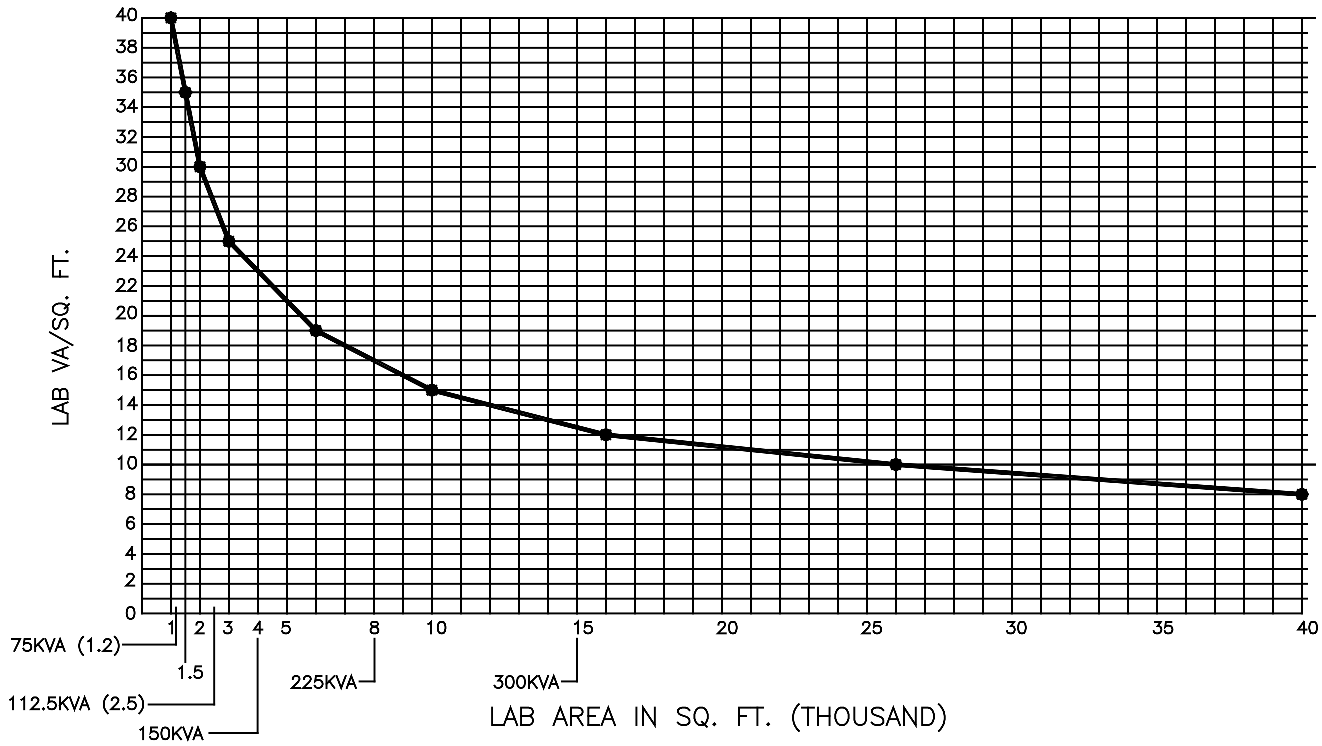


NOTES:

- EXCLUDING LIGHTING AND SPECIAL EQUIPMENT.
- EXCLUDING RELATED STORAGE, OFFICE, OR RECEPTION AREA.
- MINIMUM TRANSFORMER AND FEEDER SIZES NOTED. (INCLUDES 40% SPARE CAPACITY)

SD–E–142

M. Low Voltage Wire and Terminations

Basis of Design

This section applies to the design and installation relating to wire and cable systems and terminations.

Design Criteria

1. Low Voltage Wire

All wiring shall be in raceway systems unless otherwise noted.

Submittals

1. For low voltage systems, submit standard industry requirements.

Products, Material and Equipment

1. Low Voltage Wire
   a. Power conductors shall be stranded copper, 98% conductivity. Number 12 AWG is the minimum conductor size.
   b. Insulation THWN or XHHW (Also THHN when 1/O or smaller)

Installation, Fabrication and Construction

1. Low Voltage Wire
   a. Provide cable ties (limit torque on ties) in panelboards, cabinets, and other unconfined spaces. Group and lace wiring neatly, and do not tie to factory-installed wiring in equipment. Bundle and tag multi-pole circuits in laboratory surface metal raceway.
   b. Branch circuits: Homeruns greater than 75 feet to first outlet shall be # 10 minimum. .
   c. Crimp terminations larger than 8awg shall be of the hexacentric type.

N. Panelboards

Basis of Design

This section applies to the design and installation of panelboards.

Design Criteria

1. UW Class N3 services building panelboards shall be front accessible and utilize group mounted thermal-magnetic molded case circuit breakers. Load Centers are not acceptable.
2. For UW Class N1, N2S, and N2P services building panelboards, provide electronic trip units with long time, short time and ground fault (LSG) protection for molded case circuit breakers. Instantaneous protection shall not be provided since it limits coordination with downstream molded case circuit breakers. Two and preferably three levels of ground fault protection are desired. Selectivity is critical to the University in order to limit the extent of power outages.
3. Provide multiple lugs or feed-through type panels when required.
4. Laboratory panels shall have double lugs.
5. Provide all 208Y/120V panels with a dedicated, isolated, full size ground bus to serve future computer equipment, and separate equipment grounding conductor bus. Provide terminals for a minimum of 50% of panel circuits on each bus.
6. Provide isolation panels for Medical Center and other special applications when required.
7. Provide “service entrance” listed service entrance applications.
8. Series rated panelboards are not acceptable.
9. Panelboards shall be 200% neutral rated when serving high non-linear type loads.
10. Locate panels in electrical rooms, electrical closets, or utility hallways on each floor. Special rooms and laboratories with highly concentrated loads should have separate panels. Do not locate panels in janitor closets or toilet room entries. Locate panels near columns, on permanent corridor walls or other permanent features to prevent future relocations.
11. Surface mounted panels are preferred to flush panels. Surface mount panels in utility spaces. In finished areas provide flush mount with full height access to ceiling for future raceways. Provide a minimum of three ¾-inch spare conduits stubbed into ceiling space.
12. Consider service rated main breaker if adding a breaker causes operational difficulty.

Submittals

1. Shop drawings for review prior to manufacture
2. Panel schedules

Products, Materials and Equipment

1. Approved Manufacturers

   a. Eaton/Cutler Hammer
   b. ABB/GE

c. Siemens

2. Cabinets and Fronts

   a. Dead front type
   b. Tight closing doors without play, when latched. Where remote controlled switch or contactor is mounted in panelboard, mount on same frame as panelboard interior with dedicated access door and key lock.
   c. Provide door-in-door construction with lockable latch fasteners on all doors. All latch components to be all-metal construction. When more than one fastener is required on a door, provide single operator handle with multi-point fasteners. Locks shall be keyed alike and match the existing standard keying system (Corbin Cabinet Lock TEU-1 or GE – 75.) Opening outer door should expose terminals and circuit breakers in a single operation.

3. Circuit Breakers and Fused Switches

   a. UL interrupting rating labeled
   b. Coordinate interrupting ratings with the Protective System Device Studies. Minimum ratings shall be as follows:

208Y/120V Panelboards	10,000 AIC symmetrical
480Y/277V Panelboards	14,000 AIC symmetrical
Fusible Panelboards	100,000 AIC symmetrical

   c. Circuit breakers shall be “bolt-in” breaker units with common trip on multiple pole breakers.
   d. Provide minimum of 20% spare breakers for lighting panels and 25% spare breakers for receptacle and equipment branch panels.
   e. Spaces shall be provided with bussing, device mounting hardware and steel knockouts in dead front.

Installation, Fabrication and Construction

1. Firmly anchor cabinets directly or with concealed bracing to building structure.
2. Mount 6’ 6” above finished floor unless otherwise required. When not located directly on wall, provide support frame of formed steel channel anchored to floor and ceiling structure.
3. Panelboards rated for 400 and 600 amps shall accept 225 amp frame circuit breakers.
4. Verify space available with equipment sizes and code required working clearances prior to submitting shop drawings.
5. Furnish cabinets prime painted. Do not field paint factory-finished panelboard or equipment covers.

6. Locate in dedicated spaces. Coordinate project construction so piping, ducts, etc. are routed around dedicated spaces above and in front of panelboards per code.
7. Provide nameplates and directories.

O. Raceways

Basis of Design

This section applies to the design and installation of raceway systems.

Design Criteria

1. **PVC** (Rigid Non-Metallic Conduit): Direct burial and concrete encased
2. **EMT** (Electrical Metallic Tubing): Interior locations where not subject to physical damage; homeruns where additional future circuits are anticipated
3. **IMC** (Intermediate Metal Conduit): Not for use in earth or embedded in concrete
4. **RGS** (Rigid Metallic Conduit): All raceways in the Power Plant, utility tunnels, and in areas subject to physical damage
5. **FMC** (Flexible Metal Conduit): Final connections to devices and equipment; use liquid-tight type for damp locations.
6. **IAC** (Interlock Armored Cable): Medium voltage cable rated for use in cable trays. Low voltage service conductors to buildings.
7. **MC** (Metal Clad) and **AC** (Armored Cable): Only for power and lighting branch circuits. Circuits shall be concealed and run from junction boxes to light fixtures and devices within the same room. Circuits shall not run horizontally around wall corners.
8. **SMR** (Surface Metal Raceway): Laboratory areas and similar applications.
9. **Wireways and Cabletrays:** Medium voltage and other special applications and special low voltage applications approved by Engineering Services. Design information for cable tray used for medium voltage systems and communications systems shall be provided separately for each system.
10. Other systems may be used with coordination and approval by Engineering Services.
11. Supplement all raceways with equipment grounding conductors.
12. Provide a raceway system for connection to campus distribution systems in the utility tunnels. This system may utilize either cable tray or conduit with large radius bends. If conduit is used, provide a 3-inch conduit for signal systems. For telephone, computers, and cable television systems, (refer to UW Technology Design Guide),
13. Refer to MV sections for additional criteria when designing raceways for the primary distribution system.

Submittals

1. Provide standard industry submittal requirements.
2. Provide support information for SMR's (i.e. conduit to raceway transitions need to be a manufactured product not field modified), cable trays and wireways.

Products, Materials and Equipment

Use industry standards for raceway systems specified and comply with the following additional requirements:

1. All 45 degree bends and greater for PVC conduit in MV applications shall be rigid metallic conduit.
2. Rigid metallic conduit shall be shall be hot-dipped galvanized inside and outside.
3. EMT, indenter fittings are not acceptable.
4. SMR shall be dual channel type. Recommended SMR shall be formed steel type. Extruded Aluminum and plastic type may be considered for some applications with coordination and approval from Engineering Services. Connections to SMR shall be through manufactured fittings only.
5. Cable trays for medium voltage applications shall be ventilated, trough, type. Side rails shall be rolled, non-cutting edges.

Installation, Fabrication and Construction

1. Conduits placed in concrete slabs are not allowed except in special cases where no other means of routing is available. With prior approval from UW Engineering Services, It may be installed in parking garages, storage facilities, and similar facilities.
2. Use of extension rings for junction boxes, splice boxes, and outlet boxes, in new construction, is not allowed.
3. Generally, conceal raceway systems. Exposed conduits are permitted only in unfinished areas, SMR systems in laboratory areas, and where approved by the Architect.
4. Provide expansion fittings for conduits passing through building construction expansion joints.

Cable Trays

5. For medium voltage systems, cable trays shall hold only one cable circuit each. Exceptions are allowed on a case-by-case basis and only with the approval of UW Engineering Services. Tray-dividing barriers shall be provided when more than one cable circuit is installed in the same tray. This barrier shall be at least as tall as the medium voltage cable diameter and securely fastened to the tray. Provide a 500kcm ground cable the length of the tray. Bond to every tray section and ground rod at every vault.
6. Provide an appropriate sized ground cable the length of the tray. Bond to every tray section and conduits that have wiring going to the tray.
7. Provide low voltage cable tray distribution system for use by all low voltage systems except fire alarm and nurse call on each floor. In general, cable tray shall be installed in building corridors above suspended ceilings except in cases where the plenum space is used for air handling. In the latter case, consider installation of cable tray below finished ceiling.

P. Switchboards

Basis of Design

This section applies to the design relating to low voltage switchboards.

Design Criteria

1. UW Class N1 facilities main switchboards shall be rear accessible. The main, tie and feeder breakers shall be of the drawout airframe type construction.
2. UW Class N2S facilities main switchboard(s) shall be rear accessible. The main and tie breakers shall be of the drawout airframe type construction. Feeder breakers shall be individually mounted, compartmentalized molded case circuit breakers. Feeder breaker sizes in the main switchboard shall be limited to the minimum ampacity breaker that can be provided with ground fault protection integral to the breaker electronic trip unit (not an external add-on accessory).
3. UW Class N2P facilities main switchboard shall be rear accessible. The main breaker shall be of the drawout airframe type construction. Feeder breakers shall be individually mounted, compartmentalized molded case circuit breakers. Feeder breaker sizes in the main switchboard shall be limited to the minimum ampacity breaker that can be provided with ground fault protection integral to the breakers electronic trip unit (not an external add-on accessory). Provide provisions for a temporary generation connection to the main switchboard. This can be provided by a molded case switch (similar to a molded case breaker but with no overload protection) or some sort of bus connection point. This connection shall be downstream of the switchboard main breaker in order to isolate the transformer.
4. UW Class N3 services building switchboard shall be front accessible and utilize group mounted thermal-magnetic molded case circuit breakers.
5. For UW Class N1, N2S and N2P service building switchboards: Provide electronic trip units with long time, short time and ground fault (LSG) protection (for both the draw-out air frame and molded case circuit breakers). Instantaneous protection shall not be provided since it limits coordination with downstream molded case circuit breakers. Two and preferably three levels of ground fault protection are desired. Selectivity is critical to the University in order to limit the extent of power outages.

Design Evaluation

The following information is required to evaluate the design:

1. Programming Phase: Description of proprietary equipment required. Point of service location and building service category. Preliminary watt/square foot value for loads anticipated.
2. Schematic Design Phase: Space requirements for working clearances and equipment replacement routing. Description of power distribution and riser diagram layouts for project and layout of the main electrical room indicating the footprints of all major equipment from each of the approved manufacturers indicating actual dimensions. Outline specifications.

3. Design Development Phase: Preliminary plans including elevations, and a final layout of the main electrical room indicating the footprints of all equipment from each of the approved manufacturers indicating actual dimensions. Preliminary fault, load and seismic calculations. Draft specifications.
4. Construction Document Phase: Final plans including front view, section views, and attachments for proper seismic and fault bracing and mounting, including the final layout of the main electrical room indicating all equipment from each of the approved manufacturers indicating actual dimensions. Final detail drawings including shipping splits, assembly data and wiring diagrams. Final fault, load and seismic calculations. Final specifications.

Submittals

1. Catalog cuts including equipment ratings, dimensions, and installation instructions
2. Listing by manufacturer standards

Products, Material and Equipment

Approved Manufacturers - Switchboards

1. GE
2. Siemens
3. Cutler Hammer

Approved Manufacturers – Network Relays

1. Electronic Technology Incorporated (ETI)
2. Cutler Hammer MPCV relays
3. Other manufacturers shall be pre-approved during the design phase.

General Technical

1. NEMA PB-2 and UL 891 design equipped with hinged and latched rear access panels and hinged front panel for breaker and metering compartments.
2. The main bus shall run continuously through the switchboard and shall include a fully rated neutral conductor, which shall be insulated from the switchboard frame and supported in the same manner as the phase conductors.
3. Insulated and isolated silver-plated copper busing
4. Provide copper ground through each vertical section.
5. Bus and connecting stabs for individual breakers shall be sized for the full capacity of the breaker frame size and not for the trip setting of the overcurrent devices. Provide protective shutters for the bus isolation when the breaker is removed. Provide fully rated vertical and horizontal bus sections.
6. Completely isolate the outgoing feeder cable terminal compartment from the main bussing, using suitable insulating type barriers. Locate at the rear of the structure, vertically aligned facing rear of section.

7. Provide terminal strips for remote control, metering and status features in an accessible cubicle. Neatly dress all control wire (horizontally and vertically) in an enclosed channel (w/removable cover) or surface mounted raceway.
8. Main devices requiring energy for operation shall be supplied power from integral bus taps or stored mechanical energy devices.
9. Provide automatic “source select” scheme to ensure continuous control power to trip units and electronic meters. Provide terminals for access to the future secondary tie control power.
10. Provide Mimic labeling on the front surface of the switchboard showing the bussing arrangement. This labeling should reflect the equipment’s one-line diagram. Include transformer and breaker representations.
11. Flexible braided connectors to transformers
12. Breaker lifting device mounted on rails
13. Spaces shall be totally equipped to accept future carriages and feeder breakers without any outages.
14. Series rated equipment is not acceptable.

Breakers

1. Drawout circuit breakers must match existing campus equipment at that location. Minimum breaker size shall be 1600 amps.
2. Provide a breaker programmer Test Kit (one required per project).
3. Solid state protective devices shall provide long time, short time, ground fault trip (LSG). Current sensing shall be true RMS current. Manufacturer: G.E. MicroVersaTrip PM, Cutler Hammer OPTIM 1050 or approved equal. The unit shall also provide full trip function test, without tripping the breaker, with the breaker either in the energized or de-energized mode. The four-digit alphanumeric display shall indicate the following:
    a. Cause of trip
    b. Instantaneous value of maximum phase and ground currents
    c. Approximate level of fault current that initiated an automatic trip
    d. Cause of trip LED shall remain illuminated if all power is lost to the breaker.
4. Main breakers shall have electrically operated closing features for remote and automatic operation.
5. Tie and feeders breakers shall be drawout breaker similar to main, without electrical operation.

Network Protection Systems

1. Refer to attached drawing, Typical Network Control Schematic as a guide for designing systems with network protection. Network protection equipment, devices, and operation shall comply with the requirement below and with the attached drawing and shall be included in the design documents. Deviations from this typical design and construction shall not be allowed unless approved by UW Engineering Services.

2. Consists of drawout power circuit breaker with electrical motor-charged mechanism closed and tripped by network relays for reverse current or undervoltage. AIC, frame and trip settings shall be provided by the drawings and verified by the protective device study.
3. Relays shall, at a minimum, consist of a master-relay (a three-phase directional relay designed to provide highly sensitive directional tripping and to close the circuit breaker if the network voltage is favorable) and a phasing relay which permits breaker closing only when the phasing voltage lags the network voltage by up to 25 degrees or leads it by up to 100 degrees. The network relays function to automatically close the breaker only when voltage conditions are such that its associated transformer will supply load to the secondary loop, and to automatically open the breaker when power flows from the secondary loop to the network transformer.
4. Provide rotary cam switch for manual-off-auto of network protection. Switch shall be manufactured by Electro-Switch Series 24 or an approved equal. (Typical switch characteristics: Heavy duty, rotary switch, UL listed, CSA certified, ESC standard 1000 compliance, ANSI/IEEE 323 compliance, IEEE 344-1975 compliance.)
   a. Manual position: The electrically operated main breaker should be allowed to recharge but not to reclose. Reclosure shall be operator-initiated and only allowed if the network relays determine the closure is acceptable.
   b. Off position: Network protection is inoperable.
   c. Auto position: The network protection control relays should fully control the auto reclosure of the main breaker.
5. For proper operation, network relaying shall work in conjunction with a stored energy device (86 relay). This locks the main breaker out from automatically reclosing after an overcurrent, short circuit or ground fault condition.
6. Current sensing shall be true RMS current.
7. Load demand reclosure controls as found on public utility networks should not be used. Reclosure should be permitted when the network voltages are correct and in proper rotation. Recloser will limit the number of breaker closure attempts to 3.
8. Network protection relays shall be mounted on a base that allow the relay to be racked out for testing and maintenance. The relay shall operate in test mode in the racked-out position.

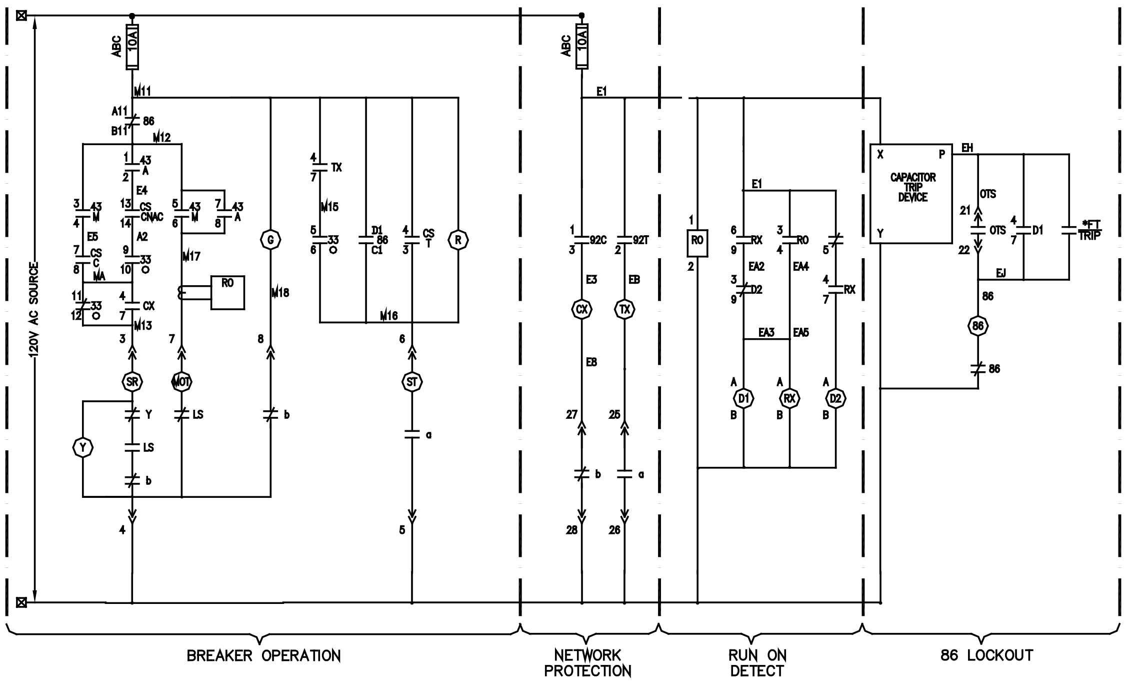
Control Power

1. Refer to attached drawings Typical Network Control Power Schematic as a guide for designing network protection control power. Network control power shall comply with the requirements below and with the attached drawing and shall be included in the design documents. Deviations from this typical design and construction shall not be allowed unless approved by UW Engineering Services.
2. For spot network and double-ended substations, provide relays and interlocking so that control power is available if one or more transformers are energized. Provide automatic "source select" scheme to ensure continuous control power to all breaker trip units, switchgear controls and electronic metering. Control power shall be derived from connections ahead of the main breaker(s).

3. Provide emergency power for electronic meters and primary switch position monitoring contacts to ensure they operate during outages and during feeder switching operations. Emergency power shall be for electronic meters only and shall not be used to provide continuous control power for trip units and switchgear controls. Switchgear control power shall be derived using the “source select” scheme, mentioned above, ahead of the main breakers(s).

Installation, Fabrication and Construction

1. Leveling rails are required for drawout equipment to insure proper alignment.
2. Installation is not complete until all electrical & mechanical tests are performed and passed.



NORMAL CONDITION

BREAKER OPEN AND RACKED OUT

DEVICE LEGEND

33 TRUCK OPERATED SWITCH. CONTACTS CHANGE STATE WHEN CIRCUIT BREAKER ELEMENT IS REMOVED FROM ITS CELL OR IN TEST POSITION.

43 CONTROL SWITCH, FOR MODE OF BREAKER OPERATION:
- 43/A–RELAY AUTOMATIC CONTROL OF BREAKER.
- 43/M–OPERATOR MANUAL CONTROL OF BREAKER.
- 43/O–NO OPERATION OF BREAKER ALLOWED.

86 LOCKOUT RELAY.

92 NETWORK PROTECTION RELAY.

* BREAKER IDENTIFICATION SUCH AS M1, F1, T1, ETC.

*/a BREAKER AUXILIARY CONTACT SWITCH, EACH CONTACT CLOSES WHEN CIRCUIT BREAKER IS IN CLOSED POSITION.

*/b BREAKER AUXILIARY CONTACT SWITCH, EACH CONTACT CLOSES WHEN CIRCUIT BREAKER IS IN OPEN POSITION.

*FT/TRIP CURRENT LIMITER (POWER FUSE) CONTACT WHICH CHANGES STATE WHEN ONE OR MORE LIMITERS OPEN.

*/OTS OVERCURRENT TRIP SWITCH, EACH CONTACT CHANGES STATE, WHEN BREAKER IS TRIPPED DUE TO GROUND FAULT, SHORT CIRCUIT, OR OVERLOAD.

CS CONTROL SWITCH, BREAKER CONTROL:
- CS/C–CONTACT CLOSES IN "CLOSE" POSITION.
- CS/T–CONTACT CLOSES IN "TRIP" POSITION.
- CS/NAC–CONTACT CLOSES IN "OFF" POSITION WHEN SWITCH WAS PREVIOUSLY IN "CLOSE" POSITION (NORMAL AFTER CLOSE; PERMISSION TO GO IN AUTO MODE).

CX CLOSE COIL.

D1 RUN ON DETECT TRIP.

D2 RUN ON DETECT TIMER.

LS LIMIT SWITCH CONTACT, OPERATES WHEN SPRING CHARGING MOTOR HAS FULLY CHARGED THE OPEN AND CLOSING SPRINGS IN THE BREAKER.

MOT MOTOR, MECHANICALLY CHARGES THE OPEN AND CLOSING SPRING IN THE BREAKER.

RO RUN ON DETECT RELAY. APPROVED: SSAC PART # ECS41BC

Rx RELAY AUXILIARY CONTACT, RUN ON DETECT.

SH/TR SHUNT TRIP COIL, OPERATES OPENING MECHANISM TO OPEN CIRCUIT BREAKER.

SR SPRING RELEASE COIL. OPERATES CLOSING MECHANISM TO CLOSE CIRCUIT BREAKER.

TX TRIP COIL.

Y ANTI–PUMP COIL, OPERATES WHEN A SIMULTANEOUS OPEN AND CLOSE SIGNAL ARE PRESENT. ANTI–PUMP PREVENTS CYCLING OF BREAKER.

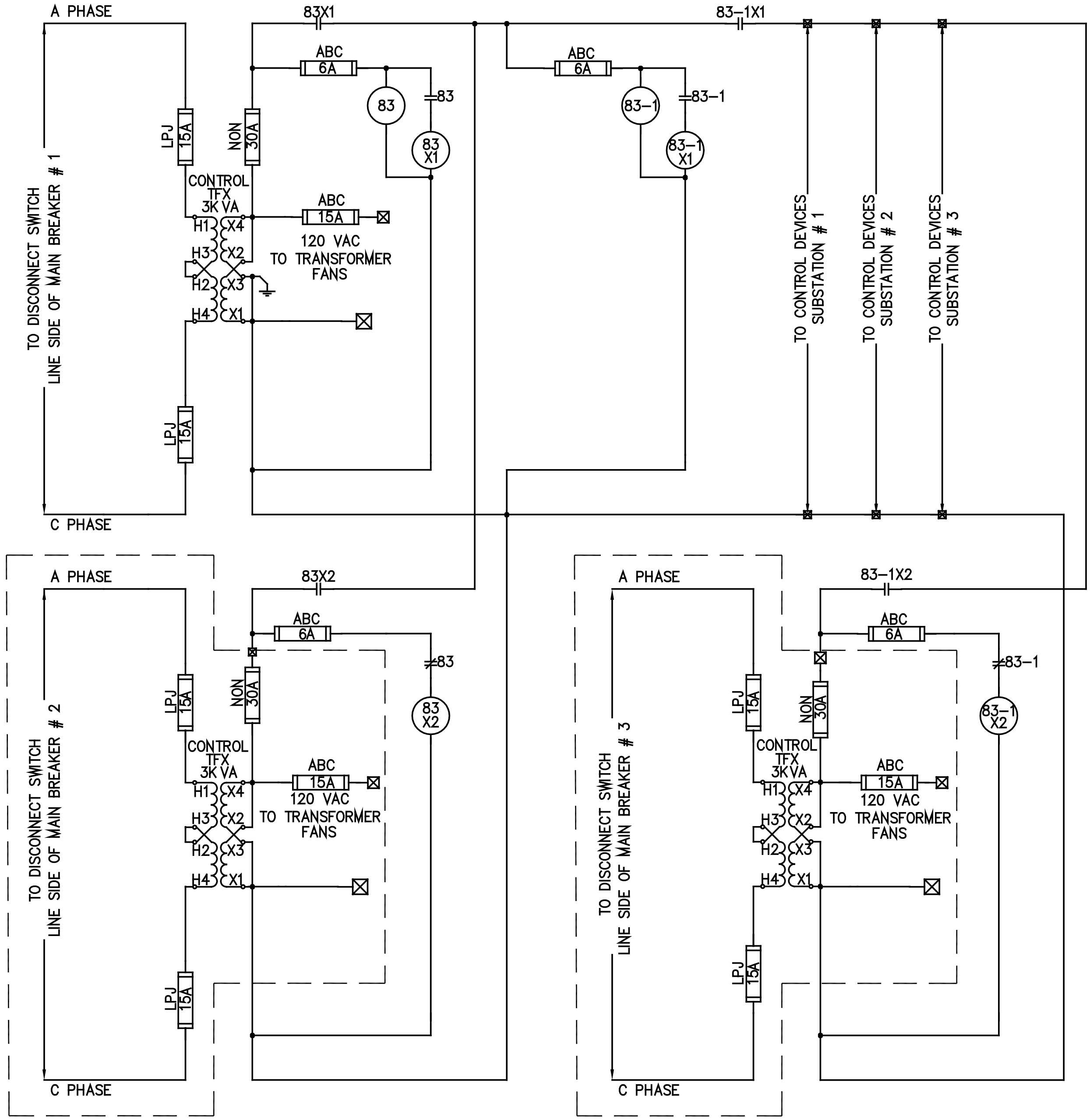
OPERATION SEQUENCE

NETWORK PROTECTION TRIP IS OPERABLE IN ANY MODE. NETWORK PROTECTION (NP) IS INOPERABLE WHEN BREAKER IS IN THE UNCONNECTED POSITION. PER PROTECTIVE DEVICE STUDY NP IS ALSO SET TO TRIP ON REVERSE MAGNETIZING CURRENT OF THE TRANSFORMER SERVED (REQUIRES AT LEAST 50 AMPS OF SWITCHBOARD LOAD)

RUN ON DETECT SENSOR (RO) TRIPS (D1) WHEN RUN ON DETECT TIMER (D2) EXCEEDS SET TIME.

CAPACITIVE TRIP DEVICE PERMITS LOCKOUT (86) FUNCTION WITHOUT CONTROL POWER AVAILABLE.

SD–E–169



CONTROL POWER TRANSFER SCHEME

SD-E-123

Q. Commissioning Support

Basis of Design

This section applies to the requirements for electrical commissioning support.

For the Commissioning Support Standard Specifications click here.

Design Criteria

1. Refer to the attached standard specifications and modify as required, to meet the project requirements.
2. Close coordination is required during the development of the construction schedule to ensure design documents stipulates electrical installation, testing, and calibration for electrical equipment shall be complete prior to the start of the commissioning process.
3. Stipulate in the design documents the requirement for electrical contractor to provide support for all commissioning activities. Electricians and technicians necessary for commissioning procedures shall be available on site.
4. Refer to Mechanical Commissioning specifications to determine scope of electrical commissioning work. Ensure that electrical equipment and systems are included in the commissioning scope. The commissioning scope shall include the following systems:

   a. Verify and document that electrical inspection, calibration, and testing requirements specified in section 16CC are complete.
   b. Functional operation of the emergency power systems including generators and automatic transfer switches (ATSs). Include power outage simulation, start-up and transfer of power to the emergency system, operation of loads connected to the emergency system, start-up and shut-down of equipment related to:

      i. Fire Alarm System
      ii. Electrical distribution systems.
      iii. Motor control centers and starters
      iv. Variable frequency drives.

   c. Lighting systems – check for proper lamp types, reflectors are adjusted and performing as specified, design lighting levels are met, and spot checks of ballast factors.
   d. Lighting control systems – Check to ensure system are programmed as designed and maintenance personnel are provided with training and manuals to reprogram the system as use and operation of the building changes.

Submittals

Refer to Electrical Commissioning Support standard specifications.

Installation, Fabrication and Construction

Refer to Electrical Commissioning Support standard specifications.

COMMISSIONING SUPPORT – STANDARD SPECS

STANDARD SPECIFICATIONS

This standard specification is intended to be integrated into the project specifications. The Consultant shall write the specifications to meet the project needs in consultation with the Owner. Items to be modified will be decided by consultation involving the Project Manager, the A/E, and Engineering Services. The A/E is expected to modify this and other specifications as necessary to accurately reflect commissioning requirements based upon specific conditions of the project.

PART 1 – GENERAL

1.01 DESCRIPTION

A. Purpose

1. The purpose of this section is to specify Division 26 00 00 responsibilities and participation in the commissioning process.

B. General

1. Commissioning support is the responsibility of the Contractor (including subcontractors and vendors).
   a. The commissioning process requires Division 26 00 00 participation to ensure all portions of the work have been completed in a satisfactory and fully operational manner. The Contractor is responsible to provide all support required for start-up, testing, and commissioning.
   b. Division 17 is intended to provide an indication of the tests, which must be performed by the Contractor prior to verification by the Owner's Representative and the Commissioning Agent.
2. Work of Division 26 00 00 includes the following:
   a. Start-up and testing of the equipment
   b. Assistance in testing, adjusting and balancing
   c. Operating equipment and systems as required for commissioning tests
   d. Providing qualified personnel for participation in commissioning test, including seasonal testing required after the initial commissioning
   e. Providing equipment, materials, and labor necessary to correct deficiencies found during the commissioning process, which fulfill contract and warranty requirements
   f. Providing operation and maintenance information and as-built drawings to the Test Engineer for verification, organization, and distribution

g. Providing assistance to the Test Engineer to develop and edit system operation descriptions
h. Providing training for the systems specified in this Division with coordination by the Test Engineer, Owner's Representative and Commissioning Agent

1.02 RELATED SECTIONS

A. The work under this section is subject to requirements of the Contract Documents, including the GENERAL CONDITIONS, SUPPLEMENTAL CONDITIONS, and sections under Division 1 GENERAL REQUIREMENTS.
B. All start-up and testing procedures and documentation requirements specified within Division 26 00 00.
C. All Division 17 commissioning procedures that require participation of Division 26 00 00.

1.03 REFERENCES

A. Applicable codes, standards, and references - All inspections and tests shall be in accordance with the following applicable codes and standards except as provided otherwise herein:

1. International Electrical Testing Association - NETA
2. National Electrical Manufacturer's Association - NEMA
3. American Society for Testing and Materials - ASTM
4. Institute of Electrical and Electronic Engineers - IEEE
5. American National Standards Institute - ANSI
6. National Electrical Safety Code - C2
7. State and local codes and ordinances
8. Insulated Power Cable Engineers Association - IPCEA
9. Association of Edison Illuminating Companies - AEIC
10. Occupational Safety and Health Administration - OSHA 29CFR Part 1910.269
11. National Fire Protection Association - NFPA

    a. ANSI/NFPA 70: National Electrical Code
    b. ANSI/NFPA 70B: Electrical Equipment Maintenance
    c. NFPA 70E: Electrical Safety Requirements for Employee Workplaces
    d. ANSI/NFPA 78: Lightning Protection Code
    e. ANSI/NFPA 101: Life Safety Code
    f. NFPA 99: Health Care Facilities

B. All inspections and tests shall utilize the following references:

1. Project design drawings and specifications
2. Shop drawings and submittals
3. Manufacturer's instruction manuals applicable to each particular apparatus
4. Applicable NETA acceptance testing work scope sections per NETA ATS 1999

1.04 COORDINATION

A. Coordinate the completion of all electrical testing, inspection, and calibration prior to the start of commissioning activities.
B. Coordinate factory field-testing and assistance per the requirements of this section.
C. The ETC (Electrical Testing Contractor) shall coordinate and cooperate in the following manner:

1. Allow sufficient time before final commissioning dates to complete electrical testing, inspection, and calibration to avoid delays in the commissioning process.
2. During the commissioning activities, provide labor and material to make corrections when required, without undue delay.

1.05 SUBMITTALS

A. General

1. Submittals shall be in accordance with Conditions of the Contract and Division 01 Specification Sections.

1.06 OPERATIONS AND MAINTENANCE (O&M) MANUALS

A. Operations and Maintenance Manuals shall be in accordance with Conditions of the Contract and Division 01 Specification Sections.

1.07 SCHEDULE

A. Complete and make fully functional all phases of Division 26 00 00 work pertinent to the Commissioning Tests, prior to the testing date determined by the Test Engineer.

1.08 MEETINGS

A. Attend Commissioning Meetings as required by the Contractor and/or the Test Engineer.

PART 2 – PRODUCTS

2.01 TEST EQUIPMENT

A. Provide test equipment as necessary for start-up and commissioning of the electrical and mechanical equipment and systems.

2.02 TEST EQUIPMENT - PROPRIETARY

A. Proprietary test equipment required by the manufacturer, whether specified or not, shall be provided by the manufacturer of the equipment.

1. Manufacturer shall demonstrate its use, and assist the Test Engineer in the commissioning process.

2. Proprietary test equipment shall become the property of the Owner upon completion of commissioning.

B. Identify the proprietary test equipment required in the test procedure submittals and in a separate list of equipment to be included in the Operations and Maintenance Manuals.

PART 3 – EXECUTION

3.01 REQUIREMENTS

A. Work prior to commissioning:

1. Complete all phases of work so the system can be started, tested, adjusted, balanced, and otherwise commissioned.
   a. Division 26 00 00 has primary start-up responsibilities with obligations to complete systems, including all sub-systems so they are fully functional.
   b. This includes the complete installation of all equipment, materials, conduit, wire, controls, etc., per the contract documents and related directives, clarifications, change orders, etc.
2. A commissioning plan will be developed by the Test Engineer and approved by the Commissioning Agent.
   a. Division 26 00 00 is obligated to assist the Test Engineer in preparing the commissioning plan by providing all necessary information pertaining to the actual equipment and installation.
   b. If system modifications/clarifications are in the contractual requirements of this and related sections of work, they will be made at no additional cost to the Owner.
   c. If Contractor-initiated system changes have been made that alter the commissioning process, the Contractor and the Test Engineer will notify the Commissioning Agent and Owner's Representative for approval.
3. Specific pre-commissioning responsibilities of Division 26 00 00 are as follows:
   a. Inspection, calibration and testing of the following equipment:
      i. Transformers
      ii. Primary switchgear and substations
      iii. Secondary switchgear
      iv. Automatic transfer switches
      v. Emergency power systems
      vi. Electrical distribution systems
      vii. Lighting control systems and lighting level verification
      viii. Fire alarm systems
      ix. Security systems
      x. Clock system
      xi. Special laboratory electrical systems

xii. Variable frequency drives
xiii. Uninterruptible power supplies

4. Normal start-up services required to bring each system into a fully operational state:
   a. These include cleaning, testing, motor rotation check, control sequences of operation, full and part load performance, etc.
   b. The Test Engineer will not begin the commissioning process until each system is complete, including normal Contractor start-up and the TAB work has been completed.
5. Commissioning is intended to begin upon completion of a system.
   a. Commissioning may proceed prior to the completion of systems, or sub-systems, and will be coordinated with the Electrical Contractor and Electrical Testing Contractor.
   b. Start of commissioning before system completion will not relieve Division 26 00 00 from completing those systems as per the schedule.

3.02 PARTICIPATION IN COMMISSIONING

A. Provide skilled technicians to start up all systems within Division 26 00 00.
   1. These same technicians shall be made available to assist the Test Engineer and Commissioning Agent in completing the commissioning program as it relates to each system and their technical specialty.
   2. Work schedules, time required for testing, etc., will be requested and coordinated by the Test Engineer.
   3. Division 26 00 00 will ensure that the qualified technician(s) are available and present during the agreed upon schedules and for sufficient duration to complete the necessary tests, adjustment, and/or problem resolutions.

B. System problems and discrepancies may require additional technician time, Test Engineer time, Commissioning Agent time, redesign and/or reconstruction of systems and system components. The additional technician time shall be made available for the subsequent commissioning periods until the required system performance is obtained.

C. The Owner's Representative and Commissioning Agent reserve the right to judge the appropriateness and qualifications of the technicians relative to each item of equipment or system. Qualifications of technicians include expert knowledge relative to the specific equipment involved, adequate documentation and tools to service/commission the equipment, and an attitude/willingness to work with the Test Engineer to get the job done.

3.03 WORK TO RESOLVE DEFICIENCIES

A. In some systems, misadjustments, misapplied equipment and/or deficient performance under varying loads will result in additional work being required to commission the systems.

1. This work will be completed under the direction of the Architect and Owner's Representative, with input from the Contractor, equipment supplier, Test Engineer, and Commissioning Agent.
2. Whereas all members will have input and the opportunity to discuss the work and resolve problems, the Architect will have final jurisdiction on the necessary work to be done to achieve performance.

B. Corrective work shall be completed in a timely fashion to permit timely completion of the commissioning process.

1. Experimentation to render system performance will be permitted.
2. If the Commissioning Agent deems the experimentation work to be ineffective or untimely as it relates to the commissioning process, the Commissioning Agent will notify the Owner indicating the nature of the problem, expected steps to be taken, and the deadline for completion of activities.
3. If deadlines pass without resolution of the problem, the Owner reserves the right to obtain supplementary services and/or equipment to resolve the problem.
4. Costs incurred to solve the problems in an expeditious manner will be the Contractor's responsibility.

3.04 SEASONAL COMMISSIONING AND OCCUPANCY VARIATIONS

A. Seasonal commissioning pertains to testing under full-load conditions during peak heating and peak cooling seasons, as well as part-load conditions in the spring and fall.

1. Initial commissioning will be done as soon as contract work is completed, regardless of season.
2. Subsequent commissioning may be undertaken at any time thereafter to ascertain adequate performance during the different seasons.

B. All equipment and systems will be tested and commissioned in a peak season to observe full-load performance.

1. Heating equipment will be tested during winter design extremes.
2. Cooling equipment will be tested during summer design extremes, with a fully occupied building.
3. Each Contractor and supplier will be responsible to participate in the initial and the alternate peak season test of the systems required to demonstrate performance, as scheduled by the Test Engineer, with three day (minimum) advance notification.

C. Subsequent commissioning may be required under conditions of minimum and/or maximum occupancy or use.

1. All equipment and systems effected by occupancy variations will be tested and commissioned at the minimum and peak loads to observe system performance.
2. The Contractor will be responsible to participate in the occupancy sensitive testing of systems to provide verification of adequate performance.

RECOMMISSIONING

A. After the initial and peak season commissioning is completed, there may be additional work required to serve new or revised loads. This work is not part of the contract.

3.05 TRAINING

A. Participate in the training of the Owner's engineering and maintenance staff, as required in Divisions 1 and 17, on each system and related components. Training, in part, will be conducted in a classroom setting, with system and component documentation, and suitable classroom training aids.
B. Training will be conducted jointly by the Test Engineer, Commissioning Agent, Owner's Representative, the design engineers, the Contractor, and the equipment vendors. The Test Engineer will be responsible for highlighting system peculiarities specific to this project.

3.06 SYSTEMS DOCUMENTATION

A. In addition to the requirements of Division 1, update contract documents to incorporate field changes and revisions to system designs to account for actual constructed configurations.
   1. All drawings shall be red-lined on two sets.
   2. Division 26 00 00 as-built drawings shall include architectural floor plans, elevations and details, and the individual mechanical or electrical systems in relation to actual building layout.
B. Maintain as-built red-lines as required by Division 1.
   1. Given the size and complexity of this project, red-lining of drawings at completion of construction, based on memory of key personnel, is not satisfactory.
   2. Continuous and regular red-lining is considered essential and mandatory.

3.07 MISCELLANEOUS SUPPORT

A. Division 26 00 00 shall remove and replace covers of electrical equipment, open access panels, etc., to permit Contractor, Architect and Owner's Representative to observe equipment and controllers provided.
B. Furnish ladders, flashlights, tools and equipment as necessary.

R. Grounding

Basis of Design

This section applies to the design and installation of electrical grounding.

Design Criteria

1. Use the UFER grounding philosophy when designing grounding systems.
2. Provide all grounding for electrical systems and equipment, including but not limited to:
   a. Service neutral
   b. Raceway systems
   c. Switchboards and panelboards
   d. "Separately derived system" (transformer or emergency power supply)
   e. Electrically operated equipment and devices
3. Ground bus is preferred in the main electrical room.
4. Provide additional grounding requirements for hospital distribution systems when required.
5. Provide additional grounding requirements for computer systems and other electrical noise-sensitive equipment when required.
6. Provide lightning protection system requirements when required.
7. Review grounding for the primary distribution system.

Products, Materials and Equipment

1. Grounding conductors shall be copper only. Use bare or green insulated in sizes #10 AWG or larger. Use green insulated for size #12 AWG.
2. Ground rods shall be ¾" x 10' 0" copper clad steel.
3. Ground connections and ground cable splices that are accessible for maintenance and repair shall be thermal welding or copper compression set type connectors UL listed for grounding purposes. Ground lugs, where provided as standard manufacturer's items on equipment furnished, may be used.
4. All ground connections underground or inaccessible for maintenance and repair shall be thermal welding only. Compression connectors are not allowed.

Installation, Fabrication and Construction

1. All branch circuits shall include a ground wire connected between the branch circuit panelboard ground bus and the wiring device or equipment ground terminal that the branch circuit serves. One ground wire in each branch circuit raceway, looped between ground terminals, is required.
2. Where ground wire is exposed to physical damage, protect with rigid non-ferrous conduit as permitted by applicable code.
3. In conduit runs requiring an expansion fitting, install a bonding jumper around the fitting to maintain continuous ground continuity.

4. Protect ground cables crossing expansion joints or similar separations in structures or paved areas from damage by means of suitable approved devices or methods of installation which will provide the necessary slack in the cable across the joint to permit movement.
5. Provide a grounding bushing with #10 ground conductor (or larger when required by code) to the grounding bus in the panelboard and switchboards.
6. See electrical VFD section for grounding requirements.

S. Inspection, Calibration, and Testing

Basis of Design

This section applies to the requirements for electrical Inspection, calibration, and testing.

For the Inspection, Calibration, and Testing Standard Specifications click here.

Design Criteria

1. Edit attached Inspection, Calibration and Testing standard specifications, as required, to meet the project requirements.
2. All inspection, calibration, and testing of electrical equipment shall be completed prior to the start of the commissioning activities. Ensure this is accounted for in the design schedule.

Submittals

Refer to attached Inspection, Calibration and Testing standard specifications.

Installation, Fabrication and Construction

Refer to attached Inspection, Calibration and Testing standard specifications.

INSPECTION, CALIBRATION AND TESTING – STANDARD SPECS

STANDARD SPECIFICATIONS

This standard specification is intended to be integrated into the project specifications. The Consultant shall write the specifications to meet the project needs in consultation with the Owner.

PART 1 – GENERAL

1.01 DESCRIPTION

A. Purpose

1. The purpose of this section is to assure that all electrical equipment, both Contractor and Owner- supplied, is operational, within industry manufacturer's tolerances, calibrated per the Power System Studies, complies with all applicable codes, installed in accordance with design specifications, and functioning in the system in the manner designed by the engineer. This effort should minimize damage and limit outages caused by electrical failures, assure proper personnel protection, and will determine suitability for reliable operation.

B. General

1. Inspections, calibrations, and acceptance tests for all equipment/systems shall be performed. The inspections and testing activities shall be divided among the following groups as specified in this section:
    a. The ETC (Electrical Testing Contractor) services shall be engaged by the electrical Contractor. The ETC shall be a recognized firm specializing in performing inspections, calibrations and acceptance tests specified in this section. The ETC shall provide all material, equipment, labor and technical supervision to perform the inspection, calibration and testing.
    b. The original equipment manufacturer’s authorized service representative shall provide special equipment, labor, and technical supervision, when required, in addition to what is supplied by the ETC.
    c. Inspections, calibrations, and acceptance tests for equipment and systems not requiring the services of the ETC and manufacturer’s representative shall be performed by the electrical Contractor.
2. In cases where equipment and systems requires the involvement of two or all of the parties, the parties mentioned above shall coordinate and perform all inspection and testing requirements. The Contractor shall be responsible for coordination of the work and ensuring that the requirements of this section are met.

1.02 QUALIFICATIONS

A. The Contractor shall retain the services of a third party ETC that is qualified to test electrical equipment, and is an approved testing company by the State of Washington Department of Labor and Industries. The ETC shall not be associated with the manufacture of equipment or systems under test.

B. The ETC shall have the inspections, calibration, and acceptance tests performed by or under the supervision, review and approval of a professional Electrical Engineer holding a current license from the State of Washington.

C. The Electrical Engineer shall be an employee of the testing company with at least 5 years of field experience testing electrical apparatus.

D. The testing company's site lead engineer shall be a licensed professional electrical engineer, who is a full time employee of the testing company, with at least 5 years of experience testing electrical equipment, troubleshooting and identifying power system and equipment deficiencies.

E. Pre-approved, subject to the qualifications, third party requirements and association restrictions stated in this section:

1. Siemens Technical Services
2. Sigma Six Inc
3. Electrotest, Inc.

1.03 RELATED SECTIONS

A. The work under this section is subject to requirements of the Contract Documents including the GENERAL CONDITIONS, SUPPLEMENTAL CONDITIONS, and sections under Division 1 GENERAL REQUIREMENTS.

B. Power System Protective Device Studies

C. Refer to Commissioning section for Contractor requirements in support of the commissioning process.

1.04 REFERENCES

A. Applicable codes, standards, and references:

1. All inspections and tests shall be in accordance with the following applicable codes and standards except as provided otherwise in this section.

    a. International Electrical Testing Association – NETA
    b. National Electrical Manufacturer's Association – NEMA
    c. American Society for Testing and Materials – ASTM
    d. Institute of Electrical and Electronic Engineers – IEEE
    e. American National Standards Institute – ANSI
    f. National Electrical Safety Code - C2
    g. State and local codes and ordinances
    h. Insulated Power Cable Engineers Association – IPCEA
    i. Association of Edison Illuminating Companies – AEIC

j. Occupational Safety and Health Administration - OSHA 29CFR Part 1910.269
k. National Electrical Code – NEC
l. National Fire Protection Association – NFPA
m. ANSI/NFPA 70: National Electrical Code
n. ANSI/NFPA 70B: Electrical Equipment Maintenance
o. NFPA 70E: Electrical Safety Requirements for Employee Workplaces
p. ANSI/NFPA 78: Lightning Protection Code
q. ANSI/NFPA 101: Life Safety Code
r. NFPA 99: Health Care Facilities

B. All inspections and tests shall utilize the following references:

1. Project design drawings and specifications
2. Shop drawings and submittals
3. Manufacturer's instruction manuals applicable to each particular apparatus
4. Applicable NETA acceptance testing work scope sections per NETA ATS 1999

1.05 COORDINATION

A. Coordinate the Acceptance Testing with the Owner and Owner Representative.
B. Coordinate ETC and factory field-testing and assistance per the requirements of this section.

1.06 SUBMITTALS

A. General

1. Submittals shall be in accordance with Conditions of the Contract and Division 01 Specification Sections.
2. Submit the ETC qualifications according to this section for approval.
3. Submit the coordinated test schedule for approval.
4. Submit detailed test procedures corresponding to the requirements in this section for approval. The test procedures shall be detailed test instructions, written with sufficient step-by-step information to allow a test to be repeated under identical conditions. List the value for all setpoints and acceptable results for each condition tested.
5. Submit a preliminary copy of the hand-written field test results to the Project Engineer and Owner's Representative no longer than one week after the test is completed.
6. Prior to energization of equipment submit a letter certifying that the electrical installation being energized complies with contract documents, code and proper system operation.
7. The test reports shall be compiled and submitted in formal form with a summary. The report shall be reviewed and stamped by the Professional Electrical Engineer.

1.07 OPERATIONS AND MAINTENANCE (O&M) MANUALS

A. Operations and Maintenance Manuals shall be in accordance with Conditions of the Contract and Division 01 Specification Sections.

1.08 SCHEDULING

A. Perform all testing after installation and before energizing. All systems shall pass tests prior to being put into service.
B. The Contractor in coordination with the ETC Engineer and the equipment manufacturer's representatives shall submit to the Owner's Representative a schedule of all tests to be performed one month prior to the scheduled performance of the first test.
C. Confirm the test schedule with the Owner's Representative one week prior to the test. The ETC Engineer shall coordinate the test schedule so that the University's Engineering Services and/or Physical Plant, at their discretion, can witness the testing.
D. The ETC Engineer shall deliver the test results to the University within 7 working days of test. The Owner shall have the tests results for a two-week review prior to equipment energization.
E. Testing and calibration of electrical equipment shall be completed prior to the start of commissioning activities. Refer to the commissioning specification to determine which systems are to be commissioned. When required during commissioning, the ETC Engineer shall retest and recalibrate equipment to support the commissioning activities.

1.09 MEETINGS

A. Pre-installation conference: The Contractor shall request a pre-testing conference with the University's Engineering Services. For projects with medium/high voltage testing, the group shall include the University's Campus Operations High Voltage Shop.

1.10 SAFETY AND PRECAUTIONS

A. Safety practices shall include, but are not limited to, the following requirements:
    1. Occupational Safety and Health Act of 1970 – OSHA
    2. Applicable state and local safety operating procedures
    3. National Fire Protection Association - NFPA 70E
B. Tests shall be performed with apparatus de-energized unless otherwise specified (e.g. rotation, phasing).
C. Power circuits shall have conductors shorted to ground by a hotline grounded device approved for the purpose.
D. In all cases, work shall not proceed until the Contractor's safety representative has determined that it is safe to do so.
E. The ETC shall have available, sufficient protective barriers and warning signs, where necessary, to conduct specified tests safely.
F. The Owner's safety procedures shall be reviewed and understood by the ETC.

PART 2 – PRODUCTS

2.01 TEST EQUIPMENT

A. All test equipment shall be furnished by and remain the property of the Contractor.
B. Test instrument calibration

1. The electrical testing Contractor shall have a calibration program, which maintains all applicable test instrumentation within rated accuracy.
2. The accuracy shall be traceable to the National Bureau of Standards in an unbroken chain.
3. Up-to-date calibration labels shall be visible on all test equipment.

C. Use of torque wrenches

1. Use calibrated torque wrenches for all bolted connections on buses and power cable terminations. Mark the head of the bolt with a colored marker pen after its being torqued to manufacturer's recommended value.

PART 3 – EXECUTION

3.01 REQUIREMENTS

A. Perform acceptance tests in accordance with manufacturer's recommendations, NFPA 70B and International Electrical Testing Association (NETA) testing specifications NETA ATS-1999.
B. Voltage adjustments shall be in accordance with SCL Standard E1-4.1.
C. The test plan, procedures, test results and reports shall be reviewed, under the supervision of and approved by the ETCs site engineer who is a licensed professional Electrical Engineers.
D. Division of responsibility:

1. The Electrical Contractor shall torque down all accessible bolts, perform routine insulation resistance and continuity tests on branch and feeder circuits and rotational tests for all distribution and utilization equipment, prior to and in addition to tests performed by the ETC specified in this section.
2. The Electrical Contractor shall supply a suitable and stable source of test power to the ETC at each test site. The ETC shall specify these requirements.
3. The Electrical Contractor shall notify the ETC Company when equipment becomes available for electrical tests. Work shall be coordinated to expedite project scheduling.
4. The Electrical Contractor shall clean all the electrical equipment prior to testing by the ETC.
5. The ETC Company shall be responsible for implementing all final settings and adjustments on protective devices and electrical equipment in accordance with the Power System Protective Device Studies.

E. Any questions or concerns identified shall be promptly addressed to the Owner's Representative.

F. Any system, material, or workmanship which is found defective on the basis of electrical inspections and tests shall be reported directly to the Owner's Representative.

G. If a test reveals a fault or problem, the entire test will be repeated until the problem is corrected. Submit additional written test reports.

H. Maintain a written record of all tests, and upon completion of the project, assemble and certify a final test report. The field test reports shall be compiled, "stamped", and signed by the site lead engineer.

I. Power systems protective device calibration

1. Adjustments, settings and modifications

   a. The ETC shall calibrate necessary field settings, adjustments and minor modifications to conform to the coordination study without additional cost. (Examples of minor modifications are trip sizes within the same frame, the time curve characteristics of induction relays, ranges etc.)

      i. Adjust protective devices to the values provided in the coordination study.
      ii. Test the minimum pickup and delay, ground fault pickup and delay.
      iii. The trip characteristics, when adjusted to setting parameters, shall fall within the manufacturer's published time-current characteristic tolerance.

2. The ETC shall verify that the protective devices have been adjusted and set in accordance with the approved protective device study.

J. Acceptance criteria

1. Each function and test shall be performed under conditions which simulate actual operating conditions as closely as possible.

   a. To that end the Contractor shall provide all necessary materials and equipment and temporary system voltages and currents to simulate fault conditions on the system being tested in order to prove and verify proper operation.
   b. At satisfactory completion of all verified tests, the building electrical system being tested shall be returned to the condition required by the contract documents as a complete and operational system.

2. The ETC shall perform general inspections at the job site and shall also review the following:

   a. Assembly of the accessory equipment, and the interconnecting wiring for control circuits and fire alarm interface
   b. General Inspection of the following: Appearance, finish, alignment of doors, covers and similar parts; quality of workmanship; possible shipping and other damage; missing, broken or incorrectly applied devices; loose or missing accessories, bushings or hardware; loose or broken wires; proper installation of all equipment; verify that shop drawings and instructions have been shipped with all equipment and are available.
   c. Support of electrical equipment: Inspect and check all electrical equipment for support and seismic bracing.

d. Spare fuses: The ETC Engineer shall inspect and verify spare fuse inventory as specified by Division 26 00 00.

3. Testing requirements and procedures

a. The following equipment and systems shall be inspected and tested by the ETC per NETA, manufacturer's instructions, and additional requirements noted.

i. Transformers

(a) All dry type greater than 600 Volt

(b) Dry type 600 Volt and below

(1) All transformers greater than or equal to 167 KVA single-phase and 225 KVA 3-phase

(c) All liquid-filled transformers.

(d) Tests

(1) Inspect for physical damage, proper installation, anchorage and grounding.

(2) Verify transformer is supplied and connected in accordance with contract documents.

(3) Verify that the transformer secondaries have a clockwise phase rotation sequence.

(4) Adjust the transformer taps to the nominal system voltages per ANSI C84.1-1989.

ii. Instrument transformers

iii. Medium voltage vacuum and air circuit breakers

iv. Cables

(a) Medium voltage cable (greater than 600V)

(1) Apply grounds for a time period adequate to drain all insulation-stored charge - minimum of 24 hours.

(2) Field test D.C. voltages (kilovolts):

Insulation Voltage Class	Acceptance Voltage	Maintenance Voltage
	New Cable	***Cable age > 10 years***
15kV AC	35kV DC	16kV DC
5kV AC	15kV DC	2.5kV DC, Megger for 10 minutes

*Prior to splicing new cable into existing, test existing cable at maintenance value. If acceptable, perform splicing, then test old and new together at the maintenance value.

v. AC and DC motors 10 hp and larger
vi. DC battery systems
vii. Surge arrestors
viii. Reactors
ix. Other utilization equipment
x. Switches (air and oil)

   (a) Verify correct wire bending radii at terminations per wire manufacturer's recommendations and NEC.

xi. Circuit breakers

   (a) Low voltage power circuit breakers (all) and insulated case/molded case circuit breakers 400a and larger and all with adjustable instantaneous trip adjustments.

      (1) Calibrate and set all breaker settings per the Protective Device Coordination Study.

xii. Protective relays and devices

   (a) Modify NETA tests according to manufacturer's recommended testing procedures.
   (b) Calibrate and set all relay settings according to the Protective Device Coordination Study.

xiii. Ground fault systems

   (a) Calibrate and set all ground fault settings according to the Protective Device Coordination Study.

xiv. Metering

   (a) Modify NETA tests according to manufacturer's recommended testing procedures.
   (b) Calibrate and set all meter configuration settings.

      (1) Settings:

         - Set Vars to + to the load.
         - Remote programming enabled
         - Request the device address from the University and set it accordingly.
         - Setup PT and CT ratios, system voltage and all other programmable parameters to make the meter and its features fully functional.

xv. Emergency off switches

   (a) Test all emergency off switches and verify shut down and reset of equipment.

xvi. Motor control

(a) Motor starters - medium and low voltage

xvii. Motor control centers

(a) Verify correct overload heaters are installed.

xviii. Variable frequency drives

(a) Electrical tests and inspections to be performed by the manufacturer
(b) Measure and document harmonics at main switchgear or a designated point of common coupling. Confirm measurements meet Division 15 requirements.

xix. Capacitors

(a) Verify that 97% power factor correction has been reached at full equipment load.

b. The following equipment shall be inspected and test by the manufacturer's authorized service representative in coordination with the ETC and the Contractor. Inspect and test according to NETA, the manufacturer's recommended procedures and the operational testing procedures described herein.

i. Spot or distributed network substations:

Special functional testing requirements are detailed below for power substations that are configured as spot or distributed networks. These procedures are based on the typical "Network Control" and "Network Control Power" schematic drawings shown in the Switchboard section. Modify procedures as needed to suit the actual network protector system provided. Items a through c shall be completed before scheduling the testing procedure with the University detailed in Items d through dd.

(a) Complete the entire installation for the unit substation including the bus tie to the other two unit substations so the entire substation is functional.
(b) Set all breaker trip unit functions per the coordination study. Remember to configure the spot network relay.
(c) The testing agency shall complete all the required testing and calibration for the entire substation and associated equipment/devices. This includes breakers, relays, and other devices set according to the Short Circuit and Coordination study.
(d) Arrange for the following testing with the UW High Voltage Shop, Engineering Services and the UW Construction Manager/Coordinator. The network relay and/or switchgear manufacturer representative should be present to assist in the commissioning process. Only the original equipment manufacturer's authorized service representative shall perform all testing associated with network protector relays. No exceptions to this requirement shall be permitted.

(e) The UW High Voltage Shop shall inspect the primary switch and unit substation for proper connection and verify phasing.
(f) Place the network Auto/Off/Manual selector switch into the off position.
(g) With the main and tie breaker open and racked out, close the primary switch to energize the transformer.
(h) The High Voltage Shop shall verify phasing, rotation and voltage at both the transformer and across the open tie breaker.
(i) Verify control voltage is present.
(j) Rack in the main breaker.
(k) Place the network Auto/Off/Manual selector switch into the manual mode. The main breaker should charge but not close.
(l) Make sure the 86 lock-out relay is reset.
(m) Close the main breaker with the breaker control switch. Check the bus and control voltage.
(n) Trip the main breaker with the breaker control switch. The main breaker should open and the breaker should recharge.
(o) Open the primary switch and discharge the main breaker spring.
(p) Place the network Auto/Off/Manual selector switch into the off position.
(q) Rack in and close the network tie breaker. Check the bus and control voltage.
(r) Place the network Auto/Off/Manual selector switch into the manual position. The main breaker should charge but not close.
(s) Attempt to close the main breaker with the breaker control switch. The breaker should not close since the primary switch is open.
(t) Place the network Auto/Off/Manual selector switch into the Auto position. The main breaker should not close since the primary switch is open.
(u) Close the primary switch. The main breaker should automatically reclose.
(v) Place the network protector Auto/Off/Manual selector switch into the manual mode.
(w) Trip the main breaker with the breaker control switch.
(x) With the main breaker NAC contact on the breaker control switch tripped (green flag), place the network Auto/Off/Manual selector switch into the auto mode. The main breaker should not reclose.
(y) Close the main breaker with the breaker control switch, resetting the NAC switch (red flag). The main breaker should automatically reclose.
(z) Trip the 86 lockout relay which should open the main breaker and lock it out.
(aa) Reset the 86 lockout relay. The main breaker should automatically reclose.
(bb) Open the primary switch. The main breaker should trip and recharge.
(cc) Close the primary switch. The main breaker should reclose.
(dd) Repeat the last two steps with the tie breaker open and also the network Auto/Off/Manual selector switch in the off and manual modes.

ii. Emergency systems

(a) Emergency generator systems

(1) Inspect and test per NETA and manufacturer's recommended start-up and testing procedures.
(2) Perform resistive and reactive load testing at .8 pf (lagging).
(3) Test phase rotation to determine compatibility with load requirements.

(b) Automatic transfer switches

(1) Coordinate with Automatic Transfer Switches Section.
(2) Verify clockwise phase rotation and in-phase transfer between the two sources of power.
(3) Adjust all timers and other parameters as recommended by the manufacture and the Engineer. A set-up sheet of final parameter settings, which includes spare columns for future modifications, shall be provided inside the enclosure.
(4) Test all the standard and optional features specified for the transfer switches.
(5) Test load management contacts, both block transfer and load shed. Simulate a load-shed signal from the CMCS (Central Monitoring and Control System) for this purpose.

(c) Uninterruptible power supplies

c. The following equipment shall be inspected and tested by the Contractor. Coordinate activities with the manufacturer's authorized service representatives and the ETC.

i. General power system tests

(a) Load balance tests: Check all panelboards for proper load balance between phase conductors, and make adjustments as necessary to bring unbalanced phases to within 15% of average load.
(b) Motor tests: Check all motors for proper rotation and measure actual load current. Submit tabulation of motor currents for all motors 10 HP and larger after the HVAC system has been balanced.
(c) Phase relationship tests: Check connections to all new and existing equipment for proper phase relationship. During such check, disconnect all devices which could be damaged by the application of voltage or reversed phase sequence.

ii. Metal enclosed ducts

(a) Inspect bus for physical damage and proper connection. Clean interior and insulators where applicable.
(b) Inspect for proper bracing, suspension, alignment and enclosure grounding.
(c) Measure insulation resistance of each bus phase-to-phase and phase-to-ground (1 minute minimum).

(d) Inspect all accessible bus joints and cable connections by infrared scanner to detect loose or high-resistance connections and other circuit anomalies.

iii. Low voltage feeder and branch circuit conductors 4/0 and larger (600V and below)

(a) Test for continuity of each circuit.
(b) Test for grounds in each circuit; test shall consist of the physical examination of the installation to ensure that all required ground jumpers, devices, and appurtenances do exist and are mechanically firm.
(c) Perform a 500 volt megohm meter test on each circuit between the conductor and ground. The insulation resistance shall not be less than 2 megohms for circuits under 115V, 6 megohms between conductor and ground on those circuits (115V-600V) with total single conductor length of 2500 feet and over, nor less than 8 megohms for those circuits (115V-600V) with single conductor length of less than 2500 feet. If conductor fails test, replace wiring or correct defect and retest.
(d) Perform torque test for every conductor tested and terminated in an overcurrent device or bolted type connection; torque all connections per manufacturer's recommendations and tabulate the results on a tabular form.

iv. Panelboards

(a) Inspect for physical damage, proper installation, supports and grounding.
(b) Verify that neutrals are grounded only at the main service.
(c) Load balance tests: Checks all panelboards for proper load balance between phase conductors and make adjustments as necessary to bring unbalanced phases to within 15% of average load.

v. Grounding systems

(a) Perform fall-of-potential test on main grounding electrode system per IEEE Standard No. 81. Maximum resistance to ground shall be less than 5 Ohms for commercial or industrial systems and less than 1 ohm for generating or transmission station grounds. If this resistance cannot be obtained with the ground system, notify UW Project Coordinator for further instruction.
(b) Verify that neutrals are grounded only at the main service by removing the service neutral grounding conductor and meggering the neutral bus.
(c) Perform point-to-point tests to determine the resistance between the main grounding system and all major electrical equipment frames, system-neutral, and/or derived neutral points. Investigate resistance values, which exceed .5 ohm. If this resistance cannot be obtained with the ground system, notify UW Project Coordinator for further instruction.

vi. Convenience receptacles

(a) Receptacle polarity test: Randomly test one receptacle in each room or hallway installed or re-connected by this project. Test for open ground, reverse polarity, open hot, open neutral, hot and ground reversed, hot on neutral and hot open. For Hospital areas add retention (pull out) test of Ground Blade per NFPA99. Rewire receptacles as required.

(b) Ground-fault receptacle circuit interrupter tests: The Test Engineer shall test each receptacle or branch circuit breaker having ground-fault circuit protection to ensure that the ground-fault circuit interrupter will not operate when subjected to a ground-fault current of less than 4 milliamperes and will operate when subjected to a ground-fault current exceeding 6 milliamperes.

vii. Special systems

(a) Service column for operating rooms

(b) Test each electrical and communication device to insure proper connections. If device does not work, find the problem and correct it. This work shall include correcting wiring inside the patient service column. Demonstrate correct polarity and show that neutral to "hot" does not exceed 68 volts AC.

viii. Isolated power system for operating rooms

(a) After the installation of the isolated power system and equipotential grounding system has been completed, an independent testing agency with assistance from the Contractor shall perform the following tests in accordance with NFPA 56A.

(1) Measure the impedance (capacitive and resistive) to ground of all conductors with the connection between the line isolation monitor and reference grounding point open. Replace wiring that measures less than 500,000 ohms.

(2) Measure the potential difference and resistances between the isolated power panel ground bus and the grounding pole of each receptacle and the patient grounding point.

(3) Also measure the potential between the grounding pole of each one of the receptacles and each of the other receptacles. The potential difference shall not exceed 10 millivolts with the system both energized and not energized.

(b) Measure system voltage.

(c) Measure readings of ungrounded system components, including isolation transformer and line isolation monitor.

(d) Measure system leakage with line isolation monitor connected in circuit.

(e) Measure system leakage with surgery track light and film viewers energized.

ix. Equipotential grounding system for operating rooms

(a) After the equipotential grounding system has been installed and prior to the walls being enclosed, the Contractor shall perform the following tests:

(1) Measure the potential difference between the grounding wire to the patient ground jack and any of the bonded exposed conductive surfaces. Correct bonding of any items with a reading over 100 millivolts.

(2) Measure the resistance between the grounding wire to the patient ground jack and any of the bonded exposed conductive surfaces. Correct bonding of any items with a reading over 0.1 ohms.

(b) After the rooms are finished and all devices are installed, the equipment manufacturer with assistance from the Contractor shall perform the same tests described above, including any items that were not installed prior to the previous tests.

(c) Record all test values and include them in the maintenance manual information. The tests shall be witnessed by the Electrical Engineer and the University's Representative. Schedule tests with Owner and Engineer at least one month prior to test date.

K. Labels

1. Upon completion of the inspection, calibration and testing, attach a label to all devices tested. These labels shall indicate the date tested, the ETC company name and tester's initials.

L. Retesting

1. Any fault in material or in any part of the installation revealed by these tests shall be investigated, replaced or repaired by the Contractor and the same test repeated by the ETC at Contractor's expense until no fault appears.

3.02 REPORTS

A. ETC shall prepare test reports on the systems tested. Include a copy of each test report in the Operation and Maintenance Manuals.

1. The ETC shall prepare test reports including the following:

a. Summary of project
b. Description of equipment tested
c. Description of test
d. Test results including retesting results
e. Test dates
f. Tester's name
g. Witnesses (when required)
h. Corrective work
i. Acceptance criteria
j. Conclusions and recommendations

k. Appendix, including appropriate test forms

T. Lighting

Basis of Design

This section applies to the design and installation of lighting systems.

Design Criteria – Interior Lighting

1. Seattle Energy Code prescriptive measures need to be discussed with UW Engineering Services.
2. Average luminaire efficiency to be greater than 75% for the entire interior lighting system. Use white reflecting surfaces with a total reflectance greater than 88% and anodized aluminum reflecting surfaces with a total reflectance greater than 93%.
3. LED luminaires are required to be vetted by the Design Light Consortium (DLC or Energy Star).
4. Custom or special order fixtures needs Engineering Services approval
5. Use realistic maintenance factors based on products actually used.
6. Do not use proprietary drivers.
7. Verify radio frequency-sensitive areas meet FCC CFR 47 Part 18 class B requirements and/or provide luminaires with sufficient RFI shielding, including shielded lenses and high integrity ground bonding.
8. Coordinate with the architect so the lighting system can be maintained. Access to the luminaires must be considered in design.
9. Evaluate luminaire equipment access (example: require that personnel bring equipment such as ladders or lifts).
10. Review with consultant / contractor during luminaire selection installation and maintenance approaches.
11. Laboratory Lighting: Provide egress lighting on emergency power near door inside of wet and large laboratories.

Design Criteria – Exterior Lighting

1. Do not use uplights and bollards for landscape lighting unless approved by Engineering Services and the UW Landscape Committee.

2. In general, pathway lighting in the UW Seattle campus are required match the performance and appearance of the Archetype series AR/SAR by KIM lighting. Other types of light fixtures will need review and approval by the UW Landscape Committee.

3. Protect all street and walkway luminaires with waterproof in-line fuse holders located in each pole base.

4. Fuses are required to be on the line side of the driver.

5. Repair or module replacement are required to be quickly accomplished without tools. The entire module are required to snap out without tools, and includes quick-disconnect plugs on all wiring. Allow for a new module to be quickly inserted to eliminate downtime.

6. The lens frame are required to be removable without tools, providing easy lens replacement in the event that breakage occurs. Require the door frame to be prevented from lifting out of its hinges when hanging in the down position.
7. Luminaires are required to fit or to be completely adaptable to existing poles utilized on campus.
8. All fixtures are required to be grounded and finished to the final mounting surface (example shrouds used so animals cannot enter the pole).

Average Maintained Foot-candles at Work Surfaces

- 70 Laboratories, drafting rooms
- 50 Paperwork-intensive offices, shops, kitchens, library study areas, etc.
- 35-42 Classrooms, lecture rooms, classroom auditoriums, computer-oriented offices and general-purpose computer work stations/labs. Consider two-level switching (50/17fc.) for mixed computers and paperwork.
- 30 Non-classroom auditoriums, conference rooms
- 20 Restrooms, mechanical and electrical rooms, locker rooms, etc.
- 10 Special computer labs: Consider two-level switching (30/10fc.) for mixed uses.

Minimum Maintained Foot-candle:

- 15 Corridors, passageways and stairways adjacent to spaces with more than 50 foot-candles
- 10 Corridors, passageways, stairways, storerooms, etc.
- 2.5 Covered parking garages (Coordinate with UW Transportation Services and UW Police for security recommendations)
- 1 Open parking
- 1 Roadway
- 0.5 Walkways

Submittals

1. Verify with consultant / contractor during luminaire selection installation and maintenance approaches.
2. Include in shop drawings a table of luminaire/driver compatibility.
3. Submit point-to-point calculations with electrical close-out documents.
4. Shop drawing as-builts are required for final delivery to UW Records.

Products, Material and Equipment

1. Mount flat lenses in frames designed for replacement with lenses up to .38 inch thick.
   a. Use clear plastic lenses that are 0.125 inch minimum thickness virgin acrylic.
   b. Use pattern 12 lenses where a diffuse light source is desired.
   c. Pattern 15 lenses are preferred to minimize imaging on video monitors.

   d. Use sealed luminaires with Corning pattern 79 glass lenses n sterile areas.

2. Sockets and screw in base luminaires are preferred.
3. Supply luminaire parts with internal disconnects. Sta-Kon disconnects by Thomas & Betts, Cat. No. LD-2, or equal are required.
4. Defective parts replacement by manufacturer are required for 10 years from the date of purchase.
5. Provide 10% spare for each fixture type.

Illuminated Exit Signs

1. Compliance with UL 924 and EPA EnergyStar Specifications at the end of 5 years of continual use
2. Green is the preferred lettering color.

Installation, Fabrication and Construction

1. Design louvers and lenses to open easily, hang open from the luminaire and be removed from the luminaire, all without the use of tools.
2. Review installation and maintenance approaches with UW Engineering Services.

U. Lighting Control

Basis of Design

This section applies to the design and installation of lighting control systems.

Design Criteria – Interior Lighting

1. Centralized and networked control systems are required.
2. Provide data connections as required to the FacNet system.
3. Automatic controllers and time clocks are required. Maintain time and schedule through a 72-hour power failure.
4. Provide BacNet connection to the Building Automation System (BAS).
5. Implement zone control for common areas.
6. Lighting control software or application shall be stored on a central server provided by the UW.
7. Provide Graphics User Interface to show light fixture status and remote programming.

Design Criteria – Exterior Lighting

1. Pathway and roadway lighting shall be connected to the "UW Cascade system"
2. All exterior lighting shall be controlled by NEMA rated contactors. Include an "Auto-On-Off-Manual" selector switch.
3. Homeruns shall be 1.5" conduit, minimum.

Submittals

1. Provide MAC Addresses for all equipment requiring data connections.
2. Provide documentation of the final commissioning report for lighting control.

Products, Material and Equipment

Interior/Classroom Lighting Control Systems

1. Approved manufacturers for centralized lighting control systems: Lutron, Legrand, Crestron, Douglas.

Interior/Classroom Lighting Control Systems

1. Cascade Lighting Control System (Existing)

Installation, Fabrication and Construction

1. Review accessibility of lighting control panels and relays for difficult access spaces such as vivaria, bio-hazard areas, operating rooms, patient rooms, and procedure rooms. Preferred locations are in the hallway outside of space.

2. Room controllers are to be located at the same location for each room (e.g. preferably by the door for access reasons).
3. Use effective and professional wire management approach (e.g. provide labelling for all wiring and terminations).
4. Locate photocells in protected accessible areas.
5. Conduit layout for controls allow for future changes to the operation of the light fixtures without having to install new conduit from lighting control panels. Size conduit for spare capacity to install additional control wires. Avoid “daisy chained” light fixtures.

V. Motor Control and MCCs

Basis of Design

This section applies to the design and installation relating to motor control centers and motor control equipment.

Design Criteria

1. MCCs shall be standard manufacturer design and construction to permit ready installation, removal, or replacement of standard components.
2. Provide continuous metering for MCC breakers that will interface with the University's centralized EMMS system.

Submittals

1. Equipment catalog cuts
2. Dimensioned installation drawings

Products, Materials and Equipment

1. Approved Manufacturers
   a. Eaton/Cutler Hammer
   b. ABB/GE
   c. Siemens
2. Construction shall be according to NEMA standards, with unit terminal strips only.
3. Starter units shall be the circuit breaker combination type.
4. Provide all motors with proper starting and overload protective devices. Provide overload protections in all three phases for three-phase motors, in all "hot" legs for single-phase motors.
5. Combination circuit breaker-type starters are preferred over separate components.
6. Full voltage starters shall normally be used. Provide reduced voltage starters in case of motors over 60HP, limited supply power, or unusual load characteristics.
7. Magnetic motor starters shall have Rotary Selector Switch "Hand-Off – Automatic" controls. This shall be for three-phase and single-phase motors. For motors without automatic control, the automatic position shall be left open.
8. Motor starter circuits shall provide demarcation terminals to allow others to introduce controls both before and after the HOA switch.
9. Manual position shall have no automatic controls except overload protection.
10. Use automatic position for any automatic control including freezestats, load shed, smoke control, remote manual control, and process control.
11. Automatic and manual positions shall have status contacts wired to the starter control terminal strip for smoke control fans and other critical motors.

12. Only intermittent, task-oriented motor starters shall have locally mounted “start-stop” push-button control (in addition to the starter HOA). If safety is a concern, local emergency stop buttons shall be provided.
13. Pushbuttons, selector switches, pilot lights bases, etc. shall be heavy-duty “oil-tight” devices.
14. Control circuits shall operate at 120 volts. 480-volt starters shall have internal control transformers; motor control centers AUG utilize a common control transformer if a control circuit fuse or breaker separately protects each unit.
15. Every control or remote pushbutton shall have an “ON” pilot light.
16. Provide red “ON” pilot light and “OFF” pushbutton.
17. Provide a green “OFF” pilot light and “ON” push button.
18. Pilot lights shall be LED type.
19. Motors over 20hp should have time delays on “restart after outage” to minimize inrush on start-up, and to prevent closing in on a back EMF. Provide staggered starting where necessary using adjustable relays.
20. Provide power factor correction capacitors for motors over 15hp. Power factor shall be corrected to 97%.
21. Electronic starters, following a power failure, shall automatically assume the mode that the starter was in before the power failure. To provide this for electronic starters, specifications need to state that electronic control modules shall provide this function.

Installation, Fabrication and Construction

1. Vertical wiring access shall be accessible from the front without opening individual control units, with hinged cover and captive screws.
2. Locate units away from high ambient temperatures and radiant heat sources.

W. Power Quality

Basis of Design

Power Distribution

1. Provide a grounding conductor in all raceways for the primary grounding path. Raceways shall serve as the secondary ground path.
2. Segregate motor, equipment and lighting loads from power quality sensitive equipment and loads. Provide dedicated circuits for medical and research equipment that are sensitive to power quality.
3. Evaluate and specify the appropriate K-ratings for distribution transformers.
4. Many power quality problems in laboratories and similar facilities are related to equipment on receptacles that are on the same circuit. The Consultant shall take this into consideration when determining the number of circuits, the layout of receptacles on the same circuit and equipment requiring dedicated circuits.
5. Research Laboratories: Design shall meet the requirements of a research institution. At minimum provide a UFER ground system. An isolated ground system may also be required.
6. Provide easy accessible points of attachment to the building grounding system in the building main equipment room.
7. Evaluate and provide the following for laboratory bench circuits, computer circuits, sensitive equipment and panelboards as required:
   a. Dedicated circuits
   b. Isolated grounds and isolated ground receptacles
   c. Transient surge suppressors
   d. Power conditioning
   e. Uninterruptible power supplies for critical loads

Surge and Transient Protection

1. Provide distribution class surge arrestors on the building main transformer primary terminals to protect from surges and transients on the primary distribution system.
2. In some cases, transient surge protection in the branch circuit panelboards might be required. The focus should be on panels with dedicated circuits that have isolated grounding provisions.
3. Transient Voltage Surge Suppression – apply as needed. These devices are not a substitute for good wiring practices by the designer.

Lightning Protection

1. Lightning protection is to be installed where equipment or liability value is high. Consult with Engineering Services in determining if a lightning protection system is required. Lightning protection is typically required for the Medical Center, Health Sciences and high-tech science lab facilities.

2. Lightning protection systems shall conform to UL Code 96A (Lightning Protection Bulletin) and NFPA Code #78. The system shall be designed as a master label system.

Submittals

Develop submittal requirements for the appropriate specification sections.

Products, Material and Equipment

Develop requirements in the appropriate specification sections.

Installation, Fabrication and Construction

Develop requirements in the appropriate specification sections.

X. Variable Frequency Drive Installations

Basis of Design

This section applies to the design of variable speed drive installations.

Design Criteria

VFDs can be a source of harmonics, which create system inefficiency and power quality problems. Perform studies and calculations to determine harmonic levels and if required specify harmonic filtering for VFDs.

Submittals

Provide standard industry submittal requirements.

Products, Materials and Equipment

Provide an individual conduit for each motor feeder being fed by a variable speed drive. The intent here is to provide isolation of the feeders so crosstalk between the feeders does not affect the operation of the variable speed drives.

Installation, Fabrication and Construction

1. Mount variable speed drives in individual enclosures that are appropriate for the environment where they are located.
2. Locate variable speed drives as close as possible to the motors they power to minimize motor feeder length. Maximum feeder length shall be 50 feet.
3. Provide continuous ground from the VFD to the motor makeup terminals.
4. Ground motor frame to the closest structural member.

Y. Wiring Devices

Basis of Design

This section applies to the design and installation of wiring devices.

Design Criteria

1. Provide 120V receptacles in janitor closets, toilet rooms, corridors, tunnels and other special purpose spaces for maintenance use.
2. In corridors, receptacles for cleaning shall be provided at spacing not to exceed 50 linear feet, near hallway intersections and rear entry vestibules. Circuits shall be separate from office and lab circuits.
3. In general, each circuit's overcurrent device should be on the same floor as the outlets.
4. Provide at least one 120V emergency receptacle in mechanical, electrical and communications rooms, connected to the building standby emergency panel.
5. Provide ground fault circuit interrupter (GFCI) receptacles as dictated by good engineering practice. Use master/slave arrangement. Reset must be accessible by users.
6. Review designation required by the SEC for switched receptacles.
7. Review floor boxes per project application

Products, Materials and Equipment

1. Use specification-grade self-grounding devices. Use hospital-grade receptacles and attachment plugs for health care facilities and laboratories.
2. AC only "quite" type switches, 20 ampere rating, self-grounding. Ivory color for normal power, red for emergency. Interchangeable type devices may be used only for special applications when approved by the Campus Engineering.
3. Use neon or low voltage transformer-base pilot lights for long life and ruggedness.
4. Device plates shall be stainless steel in finished areas, galvanized or cast to suit boxes in areas where exposed wiring is permitted.

Installation, Fabrication and Construction

Use hard ground pigtails. Do not rely on a device's self-grounding feature.

Z. Miscellaneous Signal Systems

Basis of Design

This section applies to the electrical design requirements relating to miscellaneous controls and signal systems.

Design Criteria

1. Coordinate design requirements for the following systems:
    a. Clock
    b. Alarms and remote monitoring
    c. Electrically operated windows and shades
    d. Automated whiteboards and projection screens
2. All systems shall be designed to utilize modern equipment and shall be arranged to provide flexibility, ease of expansion and accessibility.
3. Provide low voltage cable tray distribution system for use by all low voltage systems. Coordinate with Electrical Raceway section.
4. Identify spaces for terminal equipment required for miscellaneous signal systems. Coordinate with the mechanical designer to provide adequate cooling in the spaces.
5. When required, a raceway system shall be provided for connection to campus distribution systems in the utility tunnels for miscellaneous signal systems.

Submittals

1. Require operating manuals, manufacturer one-lines, and manufacturer equipment and raceway size calculations.
2. As-built drawings

Products, Material and Equipment

1. Clocks – Simplex 4 wire

Installation, Fabrication and Construction

1. Provide flush mount back boxes.

Conveyance

A. Basis of Design

This section applies to passenger and freight elevators.

Background

1. The AHJ (Authority Having Jurisdiction) is Labor and Industries State Elevator Inspector. AHJ for Fire Safety is the Seattle Fire Department.

Programming

1. Provide a traffic analysis to determine capacity and speed requirements. Where elevators are the primary means of access provide requirement that the waiting time not exceed 30 seconds.
2. In multi-elevator situations, size and speed shall be such that with one elevator out of service, the other elevator(s) shall be able to handle 60% to 80% of the normal traffic load.
3. Provide multi-elevator situations where accessibility is essential otherwise, provide for a practical alternative for maintaining accessibility per ADA Title II when the primary elevator is out of service.
4. Provide stops at mechanical penthouse(s) and basements.

Design Criteria

1. Traction elevators are the preferred means of conveyance in buildings. Hydraulic elevators may also be considered but are restricted to a maximum shaft length of 50 feet and a maximum of four stops. Provide traction elevators in buildings with five stops or more and in buildings with high traffic loads.
2. For traction elevators, gearless motors are preferred and machine room-less (MRL) may also be considered.
3. Telescoping hydraulic, hole-less hydraulic, and roped hydraulic elevators must not be used.
4. Hydraulic elevators must not be used where the water table is high enough to be in contact with the piston cylinder assembly.
5. Dual-purpose freight/passenger elevators can be substituted for dedicated freight elevators in special situations or as a practical alternative as programming requirements indicate. Floors shall be freight rated.
6. Stair railing mounted wheelchair lifts are unacceptable. Wheelchair lifts are only allowed in specific, special circumstances. Coordinate with Engineering Services and Project Manager.
7. Renovated elevators shall be upgraded to meet current Elevator Code to the extent practical.
8. Provide tamper/vandal resistant cab signals, hall call station signals and lighting systems.
9. Car interior wall finishes shall be durable and low maintenance. Floor finishes shall be durable and non-slip. Ceiling finishes shall be durable and easily cleaned. Bright, mirror-like finish for stainless steel is not desired because of the difficulty with cleaning and repair. Glass panels are not acceptable.
10. Size shaft/hoistway to accommodate all manufacturers for the type of elevator specified. Do not provide a shaft/hoistway that accommodates only one manufacturer's size of elevator.

11. Provide seismic detectors.
12. Pit shall have clearances under car for safety of workers in the pit. Access shall be by ladder or walk-in type of pit.
13. Locate call buttons at 36 inches AFF from button nest centerline.
14. Provide mechanical cooling and consider a reflective roof coating at machine room to maintain code mandated room temperatures.
15. Response time for emergency by elevator contractor during warranty and service maintenance period shall be 2 hours maximum.

Electrical

1. The most common power supply is 480Y/277 volt, 3 phase, 4 wire grounded; 208Y/120, 3 phase, 4 wire grounded power supply is acceptable.
2. Lighting power supply is 208Y/120 volts. Provide a 15 amp (max) breaker disconnect in the machine room.
3. Analyze power supply to address power quality, particularly total harmonic distortion. Refer to Elevators standard specifications for specific requirements.
4. Provide additional data (FacNet) line to machine room for future remote controller interface.
5. Elevator pit(s) shall have a light for general illumination and a GFI outlet. Provide for required electrical power for testing and adjusting equipment.
6. Emergency Power and Battery Backup: Provide ONLY when required by Code.
7. Fire Alarm Supervisory – Provide power disconnecting means that does not send a FA supervisory signal when the elevator is powered “off” for service.

Mechanical

1. Provide machine room with mechanical cooling system to maintain operating temperature as required by manufacturer for equipment operation.
2. Provide shaft pressurization as required. Refer to Architectural - Roofing for roof-mounted equipment. Center closing doors perform best for maintain shaft pressure. Reduce the car/shaft gap when doors are open to maintain shaft pressure.

Conveyance – Standard Specifications

The following Standard Specifications are intended to be typed, generally verbatim, into the contract specification. An asterisk beside an item in the following indicates an item which is variable for each project. Where [ ] appear, this indicates requirements which are optional depending upon the type of elevator being provided. The handling of such items will be decided by consultation between the Project Manager, the A/E, Facilities Services, and Environmental Health and Safety (EHS). The A/E is expected to modify other portions as necessary to accurately reflect conditions of the project.

A. ARCHITECTURAL – ELEVATORS

PART 1 – GENERAL

1.01 SCOPE

A. Contractor shall provide all services and materials to furnish and install an [electric traction] [electric hydraulic] [passenger/freight elevator], or [passenger elevator with freight capability] as described by the contract documents.

1. General Conditions, Amendments to the General Conditions, Special Conditions, Instruction to Bidders, Division 1 and all addenda of these specifications are part of the Elevator Specifications.
2. Applicable documents
    a. Americans with Disabilities Act Accessibility Guidelines (ADAAG), and the equivalent Washington state codes, whichever are more stringent
    b. Washington State regulations, including the following:
        i. Chapter 70.87 RCW Elevator, Lifting Devices, and Moving Walks
        ii. Chapter 296-96 WAC Safety Regulations and Fees for All Elevators, Dumbwaiters, Escalators and Other Conveyances.
        iii. Within this section, these are referred to collectively as the Elevator Safety Code. Any reference herein to the Elevator Safety Code includes the applicable provisions of any and all of these chapters of WAC.
    c. Safety Code for Elevator and Escalators ASME A17.1 latest edition including Elevator Safety Requirements for Seismic Risk Zone 2 or greater
    d. Inspector Manual for Electric Elevator, ASME A17.2.1.
    e. NFPA 70, National Electric Code-latest version
    f. International Building Code Chapter 30
    g. ASTM A167, Steel, Sheet Stainless
    h. ASTM A366, Steel, Sheet, Carbon, Cold Rolled, Commercial Quality
    i. AWS D1.1, Structural Welding Code - Steel
3. Permits and codes

a. All equipment and installation work shall comply with requirements of the Elevator Safety Code, and other applicable codes of the State of Washington, County and City.
b. Give necessary notices, obtain licenses and permits, and pay fees and other costs, including making arrangements for all inspections and tests required by regulating agencies, in accordance with the General Conditions as amended, the Supplemental Conditions, and Division 1 of this specification.
c. File necessary plans, prepare documents, and obtain necessary approval of governmental departments having jurisdiction and required certificates of inspection for work, in accordance with the General Conditions as amended, the Supplemental Conditions, and Division 1 of this Specification, and deliver these to the Architect before requesting acceptance and final payment for work.
d. Contractor is not relieved from furnishing and installing work shown or specified which may be beyond requirements of ordinances, laws, regulations and codes.

1.02 CONSTRUCTION DRAWINGS

A. Drawings are partly schematic in nature and do not attempt to show exact details.

1. The Contractor shall carefully check space requirements to ensure that equipment being provided can be installed in the spaces allotted.
2. No extra will be allowed for differences between actual measurements and scaled measurements or stationing.

B. [Alternate for renovation]

1. Drawings are partly schematic in nature.

a. The drawings show the best known location of existing equipment but do not attempt to show exact details.
b. The Contractor shall verify exact distances between points shown on the drawings by actual measurements at the site.
c. No extra will be allowed for differences between actual measurements and scaled measurements or stationing.

C. Cutting and patching: Openings required in the exterior of the existing structure shall be made by drilling or cutting. Contractor shall provide all pipe sleeves, anchor plates, hanger supports, inserts, and bolts required for this work. Contractor shall provide the required space in the front hoistway walls for the new hall push button stations, including the car to main floor intercom. [Applicable to renovation only]

D. Demolition: Contractor shall remove existing elevator and ancillary equipment that will not be retained. All equipment shall be removed from the site and disposed of abiding with all Federal, State, County, City, and all other regulations, laws and codes that in effect during the disposal. Contractor shall remove such items from the site. The owner has the option to have such items delivered to a location designated by the owner. All costs to remove and deliver such items shall be the responsibility of the contractor. [Applicable to renovation only]

E. Standard products: Unless otherwise indicated, the equipment to be furnished under these specifications shall be the standard products of manufacturers regularly engaged in its production.

1. Apparatus, equipment and systems furnished must be similar and equal with respect to quality, functional performance, capacity and efficiency.
2. Where the actual equipment furnished requires certain changes in pipe location, controls, electrical equipment and foundations, the Contractor shall coordinate such changes and submit them for approval.

F. Submittals: Submit shop drawings and electrical power disconnect schematics for approval. They shall contain enough detailed information to determine that the equipment conforms to the requirements of this specification and not less than the following information:

1. Elevator diagrams showing service to each level of building
2. Show location of machinery and controls in machine rooms, layout of the hoistway in plan and elevation and all other layout information and clearance dimensions required by the Elevator Safety Code.
3. Arrange the elevator equipment in a neat and workman-like manner so that all valves, fittings, etc. are readily accessible.
4. Submit layout drawings as required by WAC 296-96-02421 to the authority having jurisdiction (AHJ).
5. Submittals to the AHJ shall have all information pertinent to the installation to determine whether the installation complies with all applicable codes.
6. Provide shop drawings which include electrical and control diagrams and schematics and catalog cuts for all contractor-furnished material and equipment, including but not limited to doors, frames, car enclosure, car frame, car and hall fixtures, controls, motors, guide rails, and brackets. Motor data must include temperature rise ratings in a form that can readily be measured in the field after installation.
7. [Traction Elevators] Arrangement and connection details of machine beams, deflector sheaves, and rails. Provide calculations and drawings for the City of Seattle Department of Planning and Development, and structural evaluation.
8. [Traction Elevators] Arrangement and connection details of pit equipment including buffers, compensating devices (if any), and pit ladder
9. [Hydraulic Elevators] Coordination information including excavation requirements for the jacks; rail, buffer and jack beam reactions; and data as specified in Rule 300.7 and Rule 301.2 of the Elevator Safety Code
10. Complete information on motor, electrical services, controls, and all other coordination information.

G. Wiring diagrams: Provide complete and legible wiring and single line diagrams showing the electrical connections (e.g. CAAMS, security, shunt trip, fire alarm, and disconnect power schematics), functions, maintenance control program (MCP) and sequence of operation of all apparatus connected with the elevators, both in the machine room and in the hoistway. Provide three sets laminated and bound into three-ring binders 12” x 18”. Furnish one complete draft set for Owner review not later than two weeks after issue of the permanent state operating certificate.

H. Installation data: Provide "as installed" wireman's original pull sheets showing raceway, junction box, traveling cable wire nomenclature and origination and termination locations. Provide a legible copy of the adjuster's final control settings, such as feet per minute, door open, door close times, car door nudging time, door dwell times and all other adjustable features and/or timers.

I. Operations and maintenance manuals

1. Furnish an operation and maintenance manual covering the stipulated mechanical systems and equipment. The manual shall comply with all requirements indicated in the Project Closeout section of the specifications. Furnish one complete draft manual for Owner review not later than two weeks after issue of the permanent state operating certificate.
2. The manual shall be complete in all respects for all equipment, controls, accessories and appurtenances stipulated. Include as a minimum the following:
    a. Drawing or diagram showing equipment location
    b. The original factory Adjuster's Manual used to adjust the specific installation (including "as-adjusted" field notes)
    c. Step-by-step procedure for start-up, operation and shutdown
    d. Maintenance instructions listing routine maintenance procedures, possible breakdowns and repairs, and troubleshooting guides for all elevator equipment, including brakes and door equipment. [Hydraulic Elevators only] Include oil flow schematic diagrams and adjusting instructions for hydraulic valves and pumps. Include cross section of seals and retainer and procedures for packing hydraulic jack(s). Provide specification for hydraulic oil.
    e. Maintenance Control Program (MCP), equipment maintenance schedules, and logs.
    f. Lubrication schedule including type, grade, temperature, range and frequency
    g. Safety precautions, including diagrams and illustrations as needed for clarity
    h. Test procedures, including no-load and full load safety tests, Seismic and Firefighter's Service
    i. Parts list, with manufacturers' names and catalog numbers. Lists shall be complete for the materials installed.
    j. Serial number of each major piece of equipment
    k. Service organizations and sources of spare parts with names, addresses, and telephone numbers
    l. Provide all service and field technical bulletins or manuals normally supplied to the factory Adjuster, and required by the state MCP program, including video tapes or other media.
    m. Add the University of Washington Elevator Shop to the mailing list for receiving factory technical instruction publications.

1.03 MATERIAL AND EQUIPMENT

A. General: Material and equipment shall be new, of the best quality used for the purposes in good commercial practice, the best of their respective kinds, and as specified. Equipment shall be standard products of reputable manufacturers. Where two or more units of the same class of equipment are required, those units shall be products of a single manufacturer. Furnish equipment complete with all parts necessary for proper operation. Material and equipment shall be cleaned, free of corrosion, and selected to provide quiet operation.
B. Type capacity, size and rating of all equipment shall be as indicated on the Drawings, and/or as specified in this section.
C. Delivery and storage: Material and equipment shall be suitably protected against corrosion, dirt, mechanical damage, weather and chemical damage before and during installation as recommended by the manufacturer and as approved by the Architect. Replace defective and damaged equipment and materials.

1.04 ELEVATOR-ELECTRICAL

A. Provide electrical components of the elevator equipment and systems, including motors, motor starters, controllers, control instruments, switches, conduit, wire, and relays under this Division as specified in this section and as necessary for complete and operable systems. Furnish interconnecting wiring for components of equipment as an integral part of the equipment. Interconnecting conduit and wiring connecting such assemblies shall conform to Division 26.
B. Electrical equipment and wiring shall conform to applicable paragraphs of Electrical Specifications and National Electrical Code.
C. For equipment with electrical components, provide UL label on each component for which published standards exist.

1.05 PAINTING

A. All exposed metal work furnished in these specifications, except as otherwise specified, shall be properly painted after installation.
B. Paint machine, controller, and other machine room equipment with color designated by Owner. Stencil elevator number on all equipment as required by code.
C. Paint machine room floor with light gray floor enamel.
D. Finishes: Structural members and other components for which finish is not otherwise specified shall have black prime coat finish.

1.06 MAINTENANCE

A. Provide maintenance service of the equipment after issue of the permanent state operating certificate and for a period of twelve months after final acceptance by university.

    1. This service shall include regular systematic examinations and onsite MCP of the installation by competent and trained employees of this Contractor; and shall include all necessary adjustments, lubrication, cleaning, supplies and parts to keep this equipment

in operation, except such parts made necessary by misuse, accidents or negligence not caused by this Contractor; and include, Annual testing prior to end of warranty. Review prior to warranty expiration.

2. Provide written reports of each service call and MCP, whether routine or emergency, describing services performed.
3. Basic service work shall be performed during regular working hours of regular working days. Emergency callback service shall be available on a 24-hour, 7-day basis. Response time shall be 2 hours maximum.

B. The final elevator installation shall be maintainable by a trained elevator mechanic without the need to purchase or lease additional tools or software to diagnose problems and/or change operational parameters of the elevator system.

1. All tools and software necessary to diagnose problems and/or change operational parameters of the elevator system shall be retained by the Owner and shall function for the life of the installed equipment.
2. Hardware and software needed for diagnosis and operating parameter modification shall be products offered as standard by the manufacturer of the control system.
3. No substitutions of proprietary circuit boards, EPROMS, hardware locks, software passwords or coding, service and repair tools shall be allowed.
4. As a condition of the installation, the original equipment manufacturer shall guarantee to sell and deliver, on a timely basis, replacement parts, service tools, training and software updates to the University and to a third-party elevator maintenance company [medical center elevators] at a fair market price.
5. Contractor shall provide copy of elevator contractor's standard traction maintenance check chart, logs, and MCP in machine room and keep current by noting maintenance duties performed at each service visit.

1.07 SPARE PARTS

A. Provide new spare parts required for maintenance of the elevator, including a complete set of fuses and contacts for all control equipment. No University of Washington spare parts will be available to the contractor for use during the warranty period. The cabinet shall be mounted in the machinery room as directed. The minimum spare parts are as follows:

1. One door operator motor.
2. One of each type of door operator circuit board for each three cars or fraction.
3. One set of door pickup rollers.
4. Cables and circuit boards for door protective devices, one of each type.
5. Spare printed circuit board of each type in the controller and power supply, one set per 5 cars or fraction. Included, but not limited to, spare circuit boards for the following: Controller, button nest, car top, hoistway, hallway, machine room and all boards in the variable voltage AC or SCR drive(s).
6. Three spare lamps of each size and type per car.

B. Deliver the spare parts not later than two weeks after issue of the permanent state operating certificate.

1. Conduct an inventory with the elevator shop and university construction representative.
2. Schedule the inventory not less than one week in advance.

C. Diagnostic tools and any necessary software shall be delivered to the elevator shop not later than two weeks after issue of the permanent state operating certificate.

1.08 WARRANTY

A. Warrant the completed elevator(s) in accordance with Washington State law and regulation, but in no case less than complete coverage of parts and labor for one year after issue, by the State, of the permanent operating permit.

PART 2 – PRODUCTS

2.01 GENERAL

A. The completed elevator installation shall conform to the Elevator Safety Code except as specifically otherwise indicated or specified.

1. The installation, including equipment, material, workmanship, design, and tests shall be in accordance with the standards, rules and specifications referenced.
2. All material and equipment shall be new.
3. Electrical materials shall meet and bear evidence of meeting the requirements of Underwriter's Laboratories or Factory Mutual Systems.
4. The equipment shall be the product of a manufacturer regularly engaged in the manufacture and installation of this type of equipment.
5. Working parts shall be accessible for inspection, servicing and repair.
6. Adequate means shall be provided for the lubrication of all wearing parts that require lubrication.

B. DESCRIPTION AND PERFORMANCE: Installation will be in accordance with the following details and consist of:

1. Quantity and type	[ ] New Electric [Traction, Hydraulic] Elevator(s)
2. Load (capacity)[2]	[ ] Pounds
3. Car speed	[ ] Feet per minute
4. Leveling	+/- $^3/_8$ inch with any load
5. Operation	[**Passenger or dual purpose elevators]**: Selective Collective Automatic as normal mode, Car-Switch Automatic Floor-Stop mode or functional equivalent selectable by switch. **[Freight Elevators]** Car-Switch Automatic Floor-Stop mode or functional equivalent.

[2] In specifying the load limits of freight or dual-purpose elevators, consideration should be given to the potential for misuse. For example, if paper or other dense material is to be moved from floor to floor, the potential for overload should be considered. If a forklift truck or other heavy-lift vehicles are to be used or readily available around the elevator, Class C machines should be considered.

6.	Performance, floor-to-floor[3]	[ ] seconds for [ ] feet rise
7.	Control	Solid state microprocessor
8.	Power supply	Primary power to be [208, 480] volts, 3 phase, 60 hertz,
9.	Rise	[ ] feet
10.	Number of stops	[ ]
11.	Number of openings	[ ] at front of hoistway, [ ] at rear.
12.	Lighting supply	120 volts, 1 phase, 60 hertz
13.	Clear car inside[4]	Not less than [ ] square feet clear floor area
14.	Type of doors for car and hoistway entrances	[Single speed, two speed][5] [center opening, side opening]
15.	Hoistway entrance and car opening size	[ ] wide X [ ] high

2.02 GENERAL MATERIALS

A. Where stainless steel is specified, it shall be corrosion resisting steel, Type 304 with 150-grit finish on exposed surfaces. Stainless steel shall have the grain of belting in the direction of the longest dimension. All surfaces shall be smooth and without waves. Bright, mirror-like finish for stainless steel is not acceptable because of the difficulty with cleaning and repair.

B. Where cold-rolled steel is specified, it shall be low carbon steel rolled to stretcher level standard flatness, commercial quality, Class 1, matte finish, complying with ASTM A 366.

C. Tamper-proof screws shall be used throughout for all face plates.

D. All light globes shall be 5,000-hour long-life, minimum.

E. All elevator keys shall be installed to match the University standards, Elevator Products Company #2, as manufactured by Chicago Lock Company, for fireman's control switch key, and Elevator Products Co. #1 for all other keys, except hatch access shall be EPCO 27 or approved equal. Coordinate with building manager for specific keyed floor call locations. All lockout calls shall be overridden by Fire Service. Provide three keys of each type per elevator.

[3] This is defined as the start of door movement to close until 90% open at the next landing. Standards are about 6 seconds for traction machines, more for hydraulic. This item is important only in buildings with heavy dependence on elevators.

[4] If programming indicates a need for special inside car dimensions (e.g. for a particular size of supply cart) put the requirements here. This will apply to inside height as well as clear floor dimensions.

[5] For heavily used elevators, single-speed center opening doors are preferred. In all installations, no more than two panels per opening are preferred.

THE FOLLOWING IS FOR TRACTION ELEVATORS

2.03 ELEVATOR MACHINERY

A. Machine

1. A [geared, gearless, machine room less] traction machine, designed and manufactured to meet or exceed the requirements of the specified duty, shall be furnished.
    a. It shall include driving motor, direct current electro-mechanical brake, [steel worm, bronze gear,] and traction sheave, all mounted on a base or bedplate.
    b. [The worm shall be high grade steel and the worm gear shall be phosphor bronze of best quality.
    c. The end thrust of worm shaft shall be taken by high grade self-aligning ball bearings, in both directions.]
    d. The replaceable type traction sheave shall be of heavy alloy iron, accurately turned and grooved for the hoist ropes.
    e. The traction sheave shall have seismic rope retainers, and dust proof bearings with suitable means for ample lubrication [and adjustable supporting shaft for proper alignment of the worm and gear.]
    f. [Soundproofing shall be provided for the geared machine, designed to minimize the transmission of noise and vibration to the building structure.]
    g. Safety guards on exposed rotating equipment and cable guards on new and existing equipment shall be provided.

B. Motor

1. The motor shall be especially designed for elevator service. It shall have torque and speed capability ample for the specified duty when operated with the solid-state power supply and control system furnished.

C. Sheaves

1. Deflecting sheaves shall be of heavy alloy iron, accurately grooved to fit ropes, of suitable size according to conditions, and fitted with heavy steel shaft. Finished installation shall include seismic roper retainers.
2. Where work platform is required deflector sheave shall be located in the machine room and connected/fastened to the hoist machine bedplate support beams.

D. Beams

1. The hoist machine and sheaves shall be supported by structural beam(s).

E. Governor

1. The car over-speed controls and safety shall be operated by a centrifugal speed governor located at the top of the hoistway in the machine room. Provide Hollister – Whitney, with no substitutions.

F. Buffers

1. [Oil buffers, spring buffers] shall be installed in the pit as a means for stopping the car and counter-weight at the bottom limits of travel. Provide for adequate working space below car when the car is at the lowest level of travel.

G. Guide rails

1. Steel T-section guide rails that meet the requirements of the Elevator Safety Code shall be provided for each car and counterweight.

H. Roller guides

1. Polyurethane roller guides, Elsco, or approved substitution, shall be provided for each car and counterweight. Car rollers shall have a minimum diameter of 6 inches. Finished installation shall include seismic roller retainers.

I. Counterweight

1. A counterweight with steel frame and filler weights restrained as required by the Elevator Safety Code shall be furnished.

J. Counterweight guard

1. A metal counterweight guard shall be furnished and installed at the bottom of the hoistway.

K. Ropes

1. The hoist ropes shall be elevator rope as required by the Elevator Safety Code. Include rope data tags.

L. Compensation

1. Provide Wisperflex type compensation, if required.

THE FOLLOWING IS FOR HYDRAULIC ELEVATORS

2.04 ELEVATOR MACHINERY

A. Each elevator shall have a positive displacement hydraulic pump driven by an electric motor and operating a hydraulic cylinder with direct plunger. The machine and all its components shall meet the requirements of the Elevator Safety Code.

2.04.1 POWER UNIT

A. Each elevator shall include a power unit consisting of the motor, pump, drive assembly, oil control unit, oil reservoir, and oil drip pan, all mounted on a structural steel base and supports. Each power unit shall have the capability of delivering oil pressure and volume to lift the assembled elevator with rated load at rated speed, with soft start capability. Volume of each oil reservoir shall be sufficient to lift its elevator through the rise specified, plus normal overtravel. Each power unit shall have a muffler in the discharge oil line near the pump and an enclosure of steel panels lined with sound-absorbing material.

B. Maximum sound generation of 60 dbA within the range of 20 Hz to 20 KHz, measured within the machine room.

2.04.2 HYDRAULIC PUMP

A. The pump shall be a submerged self-contained power unit or a discrete pump-motor set mounted outside the oil reservoir. The pump shall be designed and manufactured for oil-hydraulic elevator service. It shall provide steady discharge with minimum pulsations, and its output shall not vary more than 10% between no-load and full-load conditions of the elevator car.

2.04.3 PUMP MOTOR

A. The pump motor shall be designed for oil-hydraulic elevator service, of standard manufacture, and of duty rating to provide the service specified herein.

2.04.4 DRIVE ASSEMBLY

A. Drive assembly shall be either direct coupling or multiple V-belts and sheaves. The number and size of belts and sheaves shall be sufficient to assure continued safe operation with a single belt failure.

2.04.5 OIL CONTROL UNIT

A. The oil control unit shall include the necessary valves all built into a single housing; welded manifolds with separate valves for each function will not be accepted. All adjustments shall be accessible and shall be made without removing the assembly from the oil line.

1. Relief valve shall be externally adjustable and shall be capable of bypassing the total oil flow without increasing back pressure more than 50% above working pressure.
2. Up start and stop valve shall be externally adjustable, and designed to bypass oil flow during start and stop of the motor pump assembly. Valve shall close slowly, insuring smooth up starts and stops.
3. Check valve shall be designed to close quietly without permitting any perceptible reverse flow.
4. Lowering valve and leveling valve shall be externally adjustable for drop-away speed, lowering speed, leveling speed and stopping speed to insure smooth down starts and stops. The leveling valve shall be designed to level the car to the floor in the direction the car is traveling when slowdown is initiated.

2.04.6 HYDRAULIC JACK

A. A hydraulic jack assembly that meets the requirements of the Elevator Safety Code shall be mounted under the car platform.

1. Cylinder shall be formed from seamless or drawn-on-mandrel steel tube, protected on the exterior with triple fiberglass wrapping sealed with epoxy resin. The cylinder may be provided in sections, provided they are factory assembled, inspected and approved for alignment, and marked for proper reassembly at the site. Length of each cylinder shall

be sufficient to accommodate the matching plungers. Diameter of each cylinder shall be sufficient for sleeving at some future time. A packing head shall be provided to allow for solid type packing.

2. Plunger shall be polished seamless steel tubing or pipe. Length of each plunger shall be sufficient to lift its car through the rise specified, plus normal overtravel. Plunger shall be provided in sections not exceeding 16 feet per section, joined with internal threaded couplings. It shall be factory polished while assembled and marked for proper reassembly at the project site. A code approved stop ring shall be welded to the bottom of the hydraulic plunger. **PLATEN PLATE SHALL NOT BE WELDED TO THE TOP OF THE HYDRAULIC PLUNGER.**

2.04.7 PIPE AND FITTINGS

A. Provide pipe and fittings of the size, type and weight recommended by the manufacturer. Provide two manual gate or ball valves in line for each elevator, one adjacent to pump and one adjacent to the jack.

B. OVERSPEED VALVE: Provide a safety (rupture) valve in each oil hydraulic line in accordance with Rule 3.19.4.7.

2.04.8 BUFFERS

A. Spring buffers shall be installed in the pit as a means for stopping the car at the bottom limits of travel. Provide for adequate working space below car when car is at the lowest level of travel.

2.04.9 GUIDE RAILS

A. Provide steel T-section guide rails that meet the requirements of the Elevator Safety Code.

2.04.10 LOW OIL INDICATOR

A. Provide indicator light on controller to indicate that reservoir is low on oil.

2.04.11 HYDRAULIC OIL

A. Provide hydraulic fluid that meets the requirements of the elevator manufacturer with minimum flammability.

2.05 ELEVATOR CAR

A. CAR FRAME, PLATFORM, and SAFETY: Provide a car frame and platform fabricated from steel with a safety plank with [Type A, Type B, Type C] car safeties. [Traction and roped hydraulic machines only]

B. SLING ISOLATION: [Traction machines] Each car shall include a means to isolate the complete car enclosure from the sounds and vibrations transmitted from the machine room through the hoist ropes. The preferred method is spring isolation of the complete car sling and enclosure assembly from the hoist rope terminations at the car sling. Acceptable alternates include:

1. A rubber mounted hitch plate
2. A platform mounted on rubber pads

C. CAR ENCLOSURE: The car enclosure shall be steel and shall comply with the Elevator Safety Code. Exterior of car enclosure shall receive a sound-deadening material coating.

1. CAR FRONT: Return panels with integral entrance columns of 14 ga minimum satin finish stainless steel shall extend from finished floor to underside of the dome. Return panel(s) shall be arranged for the mounting of applied fixtures.
2. CAR TOP: The car top shall not be thinner than 14 ga cold-rolled steel suitably reinforced. Finish shall be [matte white painted or as selected for the specific project].
3. HANDRAILS ON SIDES AND REAR: 1 ½-inch round handrails [stainless steel or as selected for the specific project] shall be provided on the two sides [and at the rear of the car enclosure, single-door cars only].
4. WALL AND FLOOR FINISH: Furnish and install [stainless steel and laminate interiors of the style offered as standard by the car manufacturer, or as selected for the specific project. Freight cabs will usually be painted steel]. Furnish and install [sheet vinyl floors, or as selected for the specific project, on passenger and dual purpose cars] [2-inch tongue-and-groove, kiln-dried oak flooring, or steel with embossed nonskid pattern, or as otherwise selected, on freight cars]. Ceramic tile or other brittle, non-resilient material is not to be used, except by specific direction of the University. Colors will be selected by the Owner from samples offered as standard by the car manufacturer.
5. PROTECTIVE PAD HOOKS AND PADS [for passenger elevators that may occasionally be used to move furniture or small quantities of construction materials]: Protective pad hooks [of stainless steel or as selected for the specific project] and fire retardant protective pads of quilted canvas duck shall be provided at all walls except the entrance walls. [If a group of two or more elevators, select one of the group for this provision].
6. EXHAUST FAN: A two-speed exhaust fan, Nylube X12F9, or approved substitution, shall be mounted on the car top.
   a. [Alternate] EXHAUST FAN AND HEATER: A two-speed exhaust fan, Nylube X12F9, or approved substitution, shall be mounted on the car top. A fan-forced electric heater with selectable 800-watt and 1200-watt elements shall be mounted in the front wall or side wall near the car operating panel, exact location to be approved by the Architect.
7. CAR OPERATING PANELS: A two-segment car operating panel shall be furnished inside the car; by EPCO or approved equal. A car top operating station shall be furnished. The inside panels shall be configured as follows:
   a. An accessible panel segment shall contain a bank of illuminated, tamper-resistant buttons marked to correspond to the landings served, an emergency call button, keyed stop switch, and door-open button. The emergency call button shall be connected to a bell that serves as an emergency signal. Raised Braille markings which comply with requirements for the handicapped shall be furnished for the car

buttons. Locate the center of each button cluster at 42 inches above the finished floor. Panel should also be capable of accommodating CAAMS, or security functions.

b. Provide an auxiliary panel with call buttons at the opposite return on larger cars with center-opening doors. Provide an auxiliary panel with call buttons at the rear door of two-door cars. For large, two-door cars, center-opening doors, in high-volume service, consider three auxiliary panels, so that there are call buttons on each of the four door returns.
c. An access-controlled panel segment shall contain light switch, utility outlet, fan switch, and switch for operating mode selection. [Add any special switches such as in-car heater, access control]. Access shall be limited by a door or panel with lock keyed to EPCO or approved equal.

8. TELEPHONE CABINET: A Ramtel Corp. Model RR733-924M security telephone shall be mounted beneath the car operating panel.

   a. Necessary wires shall be included in the car traveling cables.
   b. The phone shall be mounted inside a cabinet in the primary car operating panel or flush mounted with a [stainless steel or other material to match the car interior] face plate. Phone shall be mounted such that it is easily removable for servicing.

9. INTERCOM: Provide a flush mounted J Phillips LLC, or equal, intercom with a stainless face-plate for communication between the car and the Phase 1 fire service recall landing. Verify operation when power is lost.
10. INTERIOR CAR LIGHTING:

    a. [Passenger and dual-purpose cars] Lighting: Provide recessed or flush mounted LED luminaires. [Freight Cars, Enclosed] Lighting fixtures shall be for fluorescent lamps and shall be recessed, with the bottom of the fixture flush with the car ceiling. Provide at least two 48-inch fluorescent lamps per car up to 40 square feet platform area. Provide one additional 48-inch lamp per 30 square feet or fraction over 40 square feet. Lighting shall be serviceable from car interior.
    b. [Freight Cars, Open] Luminaires shall be LED, not fewer than two per car.

11. EMERGENCY CAR LIGHTING: A Nylube Products Model EL-SS emergency power unit or approved equal shall be provided to illuminate the elevator car and provide current to the alarm bell in the event of power failure.

    a. If emergency power circuit is available, car lighting and alarm bell also shall be connected to the life safety panel of the building.

12. EXTERIOR CAR LIGHTING AND POWER: Provide a work light with switch and a duplex GFCI type utility outlet on the car top. The light shall be located to illuminate the cartop operating station, the hoistway door mechanisms, the car locator mechanism, and limit switches.
13. ALARM BELL: Provide a Nylube Model ELB-6 alarm bell, or approved equal.
14. TRAVELING CABLES: A traveling cable shall be provided for electrical connections between each car and its hoistway.

a. Each cable shall have adequate conductor capacity for all control, communication and lighting functions specified herein. Provide two spare lighting/utility circuits, and four spare communications circuits in each cable.
b. Each cable shall have flame retarding and moisture resisting outer cover. Cables shall be flexible and shall be suitably suspended to relieve strains in the individual conductors.
c. Terminate all conductors on a terminal board with permanent identification matching that used in schematic and wiring diagrams.

2.06 POWER AND CONTROL DEVICES

A. [Electric Traction Elevators] Solid state power supply and logic control

1. Provide non-proprietary solid state elevator controller from Motion Control Engineering, Elevator Controls Corporation, Kone, or Smart Rise to operate the elevator. No substitutions.
2. Provide Modbus TCIP gateway with controller for remote diagnostics and monitoring. Provide a dedicated data line to the elevator machine room.
3. The maximum Total RMS Harmonic Distortion (THD) contribution to the building power distribution network, from the elevator drive and hoist system, shall be restricted for voltage (THDV) and current (ampere) (THDI). The RMS total harmonic distortion is defined as the amount of harmonic distortion as a percentage of the rms value of waveforms at all frequencies (fundamental and harmonic). The following THD criteria is to be understood as RMS unless otherwise noted:

a. THD will be measured and compared to the building THD. The building THD will be measured with the new elevator systems disconnected from the building power distribution system.
b. The building THDV and THDI, with the elevator disconnected, will be measured at each elevator's feeder disconnecting means.
c. The elevator THDV and THDI will be measured at each elevator's feeder disconnecting means located in the elevator equipment room. Individual measurements will be taken with each elevator operating at 0%, 25%, 50%, 75% and 100% of the full rated load at contract speed in the up and down direction.
d. The maximum allowable THDV and THDI will be the calculated difference between the building THDV and THDI measurements and the elevator THDV and THDI measurements respectively.
e. Maximum allowable THDV from each elevator motor drive is 3% or the value of the building THDV measured in part b above, whichever is greater.
f. Maximum allowable THDI from each elevator motor drive is 15%. No individual current harmonic shall exceed 10% relative to the fundamental (THDI-F). THDI-F defines the amount of harmonic distortion as a percentage of the fundamental frequency current.
g. Measurements shall be taken upon substantial completion by an independent firm.

i. The above criteria will be the result of the average of three readings for each measurement with a minimum 10-minute interval between each reading.
ii. The metering equipment shall be a Fluke 41 System Analyzer or approved substitution.
iii. Provide safe access to open electrical equipment and the assistance of one qualified electrician for taking the readings.

4. Harmonic distortion control may be accomplished by integral design techniques of the elevator control system, adding internal equipment/devices, or adding external equipment/devices.
    a. Harmonic filtering separate from the elevator controls may be accomplished using a "Capaci-Trap" filter manufactured by the Myron Zucker Company, or approved substitution.
    b. A representative for Myron Zucker equipment may be reached at (800) 245-0583 for pertinent application information.
5. Solid state power control: Provide a solid state power controller to operate the hoist motor, brake, and other electromechanical devices.
    a. The controller shall include interfacing pilot electromechanical devices as required for accepting the necessary elevator hoistway switches and operating switches.
    b. These include, as a minimum, terminal slowdown devices, overtravel limit switches, solid state magnetic leveling switches, inspection operating pushbuttons, emergency stop switches and governor over-speed switches.
6. Microprocessor elevator logic control: The operation shall be accomplished utilizing microprocessor computer logic control.
    a. The elevator control program shall be contained in nonvolatile, programmable, read-only memory.
    b. The control shall be constructed such that future alterations in elevator operation including changes of operating parameters (including but not limited to speed, acceleration, jerk, pre-opening, door speed, door dwell, floor counts for leveling, and car zoning) readily be made as part of normal maintenance and service. If a separate, detachable device is required, it shall be furnished.
    c. Safety circuits shall be monitored and controlled by the programmable logic control with redundant protection. The microprocessor elevator logic control shall be contained in a NEMA 1 cabinet.
7. Fault diagnosis: Provide capability to diagnose faults to the level of individual circuit boards and individual discreet major components for both the solid state power controller and the elevator logic controller. (Capability to diagnose faults within an individual circuit board is not required.)
    a. If fault diagnosis requires a separate, detachable device, it shall be furnished.

B. [Hydraulic Elevators] Solid state logic control: Provide a reduced voltage motor starter and solid state logic controller from Motion Control Engineering, Computerized Elevator

Controller, or O. Thompson to operate the elevator at the specified conditions. Provide modbus TCIP gateway with controller for remote diagnostics and monitoring.

1. Solid state power control: Provide a solid state logic controller to operate the pump motor, valves, and other electromechanical devices.
    a. The controller shall include interfacing pilot electromechanical devices as required for accepting the necessary elevator hoistway switches and operating switches.
    b. These include, as a minimum, terminal slowdown devices, over-travel limit switches, solid state magnetic leveling switches, inspection operating pushbuttons, and emergency stop switch.
2. Microprocessor elevator logic control: Accomplish the operation utilizing microprocessor computer logic control.
    a. The elevator control program shall be contained in nonvolatile, programmable, read-only memory.
    b. Construct the control such that future alterations in elevator operation, including changes of operating parameters (including but not limited to speed, acceleration, jerk, pre-opening, door speed, door dwell, floor counts for leveling, and car zoning) readily be made as part of normal maintenance and service.
    c. If a separate, detachable device is required, it shall be furnished.
    d. Monitor and control safety circuits by the programmable logic control with redundant protection.
    e. Contain the microprocessor elevator logic control in a NEMA 1 cabinet.
3. Fault diagnosis: Provide capability to diagnose faults to the level of individual circuit boards and individual discreet major components for both the solid state power controller and the elevator logic controller. (Capability to diagnose faults within an individual circuit board is not required.)
    a. If fault diagnosis requires a separate, detachable device, it shall be furnished.

C. Emergency power operation (ONLY when required by code): For new controllers, provide the capability of emergency power operation as follows: Upon loss of normal building power, the elevators shall switch to emergency power operation.

1. [For single elevators:]
    a. Upon transfer to emergency power, the elevators shall stop and return to the nearest landing and shut down with doors open.
    b. Following return to the nearest landing, the elevator shall have the capability of being reactivated on emergency power by key switch in the car operating panel.
2. [For elevator groups or high rises:]
    a. Upon transfer to emergency power, the elevators shall stop and return, one at a time sequentially, to the Phase I primary recall landing, and shut down with doors open.
    b. Following return to the Phase I primary landing, the elevator shall have the capability of being reactivated on emergency power by key switch in the car operating panel.

3. Firefighter service shall have the ability to override the emergency power recall landing. If the lobby detector on the primary landing level has activated and power transferred to emergency, the elevators shall return to the alternate firefighter recall level rather than the primary.

D. Firefighters' service: Provide all elevator control functions, car operating devices, and hall operating devices necessary for "firefighter's service - automatic elevators" as required by the Elevator Safety Code.

1. The "designated level" shall be [ ], and the "alternate level" shall be [ ]
2. Provide a key box for each recall station and for each elevator machine room door, the box locks to match the Seattle Fire Department standard key.

E. Terminal limit switches: Provide terminal limit switches in the hoistway designed to automatically stop the car at terminal landings.

1. Design the final hoistway limit switches to automatically cut off the power and apply the brake, should the car travel beyond either terminal landing.

F. Automatic Leveling Device: Provide the elevator with a two-way automatic maintaining leveling device.

G. Car and hall position indicators: Provide LED car position indicator integrated with the main operating panel [On two-door cars only:

1. Provide a LED car position indicator near the rear door]. [A hall position indicator shall be installed at the main floor landing.]

H. Hall buttons: At each terminal landing, provide a recessed, tamper resistant signal push button, designed to accommodate serial boards together in the same removable unit by EPCO, or approved equal.

1. At each intermediate landing, provide a button fixture containing recessed, tamper resistant "UP" and "DOWN" push buttons.
2. Locate each single button and/or the center of each button pair 36 inches above the finished floor.
3. Provide an elevator use-control switch with lock keyed as specified in Paragraph 2.02, E; coordinate location with the University Elevator Shop.
4. The "ON" position shall allow any specified operating mode, and the "OFF" position shall cause the car to park at the bottom terminal landing.
5. Furnish raised Braille markings which comply with requirements for the handicapped for the car buttons.
6. CAR DIRECTION LANTERNS AND SOUND SIGNALS: Provide direction lanterns in each car adjacent to or integrated with the car position indicator.
7. A chime shall also be furnished on the car which will sound once for the "UP" direction and twice for the "DOWN" direction as the doors are opening.

I. HALL DIRECTION LANTERNS AND SOUND SIGNALS: [For groups of two or more cars] Provide direction lanterns above each hoistway door.

1. Provide a gong or chime for each hoistway door. Interconnect lanterns and gongs/chimes with the car controllers to provide advance notice of car arrival.
2. By C E Electronics Inc., no substitutions
3. [For single-car installations and two-car groups with limited traffic] Provide direction lanterns recessed in the car back panel.
   a. Provide a gong or chime, readily audible from the landing that sounds as the doors begin to open.

2.07 ENTRANCES

A. HOISTWAY ENTRANCES: [Passenger and Dual Purpose Elevators] Provide new UL labeled metal doors and hoistway door frames.

1. Doors shall be [stainless steel, cold-rolled steel].
2. Provide bottom of doors with removable phenolic guides which run in the sill slots with minimum clearance. Provide two (2) gibs per door panel, one at the leading edge and one at the trailing edge, including fire tabs. Provide additional steel plate gib between each standard door gib. Plate shall span a distance of at least 4” between each standard door gib. Plates shall vertically penetrate into the hoistway door sill groove the maximum vertical distance without bottoming out on the door sill. Provide luner key access at each landing including the Tri-Lock device.
3. [Where pressurization will be included:
   a. Design doors to accommodate hoistway pressurization of 0.10 inches water column while remaining fully operational.
   b. Design doors for low air leakage under pressurization.]
4. Provide manual access with lunar key or other approved device at each entrance. And on every floor and to be located at the upper right interior (hall side of frame), provide the elevator number at least 2 inches in height either in metal stamped or etched plastic.
5. [Freight Elevators] Provide new UL labeled hoistway door frames and [manually] [power-] operated bi-parting door assemblies, complete with guides and accessories for proper operation.
   a. Design doors so that upper and lower panels counterbalance each other.
   b. Provide the lower edge of the upper door section with a fire-resistive safety astragal with non-shearing and non-crushing properties with respect to foreign objects, up to 3/4-inches thick, upon which the two door sections close. Provide rubber bumpers on the lower edge of the upper panel frame near each jamb, mounted to provide the astragal safety action specified. The rubber bumpers and safety astragal shall be designed for replacement.
   c. Equip the upper edge of the lower door section with a metal sill designed to be level with the landing when the doors are fully open. The sills shall be of sufficient size and strength to bridge the space between the building sill and the car platform and to support a trucking load commensurate with the load class of the elevator car. The sill shall extend the full width of the door opening.

d. If powered doors are used, the hoistway doors and car doors shall be actuated by separate door operators.
e. [Where pressurization will be included, design doors to accommodate hoistway pressurization of 0.10 inches water column while remaining fully operational. Design doors for low air leakage under pressurization.]
f. Provide manual access with lunar key or other approved device at each entrance. Provide elevator number.

B. FASCIA PLATES: Provide fascia plates, fabricated from 14 ga steel, to be fastened to the header and the sill above. Fascia plates shall have manufacturer's standard enamel finish.

C. LANDING SILLS

1. [Passenger Elevators] Provide extruded nickel sills together with all necessary supports and hardware for installation.
   a. Install in accordance with manufacturer's recommendations.
   b. Grout sills solidly their full length after installation.
2. [Freight and dual purpose Elevators] Provide steel sills to match the doors selected, together with all necessary supports and hardware for installation.
   a. Install in accordance with manufacturer's recommendations.
   b. Grout sills solidly their full length after installation.

D. DOOR HANGERS AND TRACKS: Provide tracks, hangers, and hanger sheaves at each car and hoistway entrance.

1. Tracks shall be of bar steel with the working surface contoured to match the sheaves.
2. Design the hangers for power operation and have provisions for vertical and lateral adjustment.
3. Design hangers for two-point suspension of the door panel.
4. Hanger sheaves shall be polyurethane with pre-lubricated and sealed bearings.

E. DUST COVER

1. Provide dust covers, fabricated from 14 ga steel, at each landing.
2. Dust covers shall have manufacturer's standard enamel finish.

F. CAR DOORS

1. [Passenger and Dual Purpose Elevators] The car entrance shall be provided with doors of minimum 16 ga facing into the car [stainless steel, or as selected for the specific project], extending around the leading door edges, and suitably reinforced.
   a. The doors shall have astragals designed for easy replacement.
   b. Provide bottom of doors with removable phenolic guides which run in the sill slots with minimum clearance. Provide two (2) gibs per door panel, one at the leading edge and one at the trailing edge, including fire tabs. Provide additional steel plate gib between each standard door gib. Plate shall span a distance of at least 4” between each standard door gib. Plates shall vertically penetrate into the hoistway

door sill groove the maximum vertical distance without bottoming out on the door sill.

c. MAC zone restrictors (included in 6, G), designed to prevent car doors from being opened when the car is outside a landing zone, shall be included in all car doors.

2. [Freight Elevators] The car entrance shall be provided with [manually] [power] operated biparting doors compatible with the hoistway doors

a. Design doors so that upper and lower panels counterbalance each other for ease of operation.

G. DOOR OPERATOR: [Passenger and Dual Purpose Elevators] Provide a door operator to open and close the car and hoist way doors simultaneously.

1. The package shall include the following: lifting rods, pickup rollers, clutch assembly, interlocks, gate lock and all related installation hardware.
2. Opening speed shall not be less than 2½ feet per second.
3. Closing speed shall not exceed the limitations set by the Elevator Safety Code.

H. DOOR EDGE PROTECTIVE DEVICE: Provide each passenger car door with an infrared type reopening device extending the full height.

I. TOE GUARD: Provide toe guards, fabricated from 14-ga steel: a) at the lowest landing of each hoistway, and b) on each car sill. Toe guards shall have manufacturer's standard enamel finish.

J. FINISHES: Structural members and other components for which finish is not otherwise specified shall have prime coat finish.

K. HOISTWAY ACCESS SWITCHES: Provide hoistway access switches, keyed as to EPCO 27 or approved equal, at upper and lower terminal landing.

2.08 PIT AND MACHINE ROOM

A. EMERGENCY STOP SWITCH: In each elevator pit, provide an emergency stop switch accessible from the pit access opening.

PART 3 – EXECUTION

3.01 INSTALLATION OF ELEVATOR SYSTEMS

A. GENERAL: Comply with manufacturer's instructions and the Elevator Safety Code for work required during installation.

B. Before beginning the installation, examine the hoistway and machine room to verify conditions and provide written notice of any conditions which would substantially hinder or prevent proper execution of the work. Do not proceed with the installation until the cited conditions have been corrected.

C. PREINSTALLATION MEETING: Prior to installation of any elevator equipment, hold a meeting of Contractor, Elevator Subcontractor, University's Construction Coordinator, and Elevator

Shop Superintendent to review installation approach and identify any special circumstances pertaining to this installation.

D. BEAM INSTALLATION

1. [Traction elevators only]: Install the machine beams and any sheave beams in accordance with a design approved by Architect and the City of Seattle.

E. JACK INSTALLATION

1. [Hydraulic elevators only]: Install the jack in a hole excavated, cased and lined to accommodate it.

    a. Casing shall be steel, not less than ¼-inch in thickness, and with interior diameter not less than 8 inches larger than the outside diameter of the wrapped jack cylinder.
    b. Prior to insertion of the cylinder, line the casing with plastic in such a manner as to prevent ground contamination with leaking hydraulic fluid. If the cylinder is shipped in sections, wrap joint areas with triple fiberglass sealed with epoxy resin prior to insertion.
    c. Install cylinder plumb and true with the hoistway. Following installation, backfill between the liner and the jack with clean, dry, salt-free sand in such a manner that alignment of the jack is not disturbed.
    d. The Architect and the Owner, including the Elevator Shop Superintendent, shall be given prior notice of the arrival of each jack at the job site. Give them ample opportunity to inspect each jack before it is installed.

F. RAILS

1. Install rail brackets as needed to meet the requirements of the Elevator Safety Code.
2. Align rails plumb and accurately centered for elevator car position and travel.

G. DOORS

1. Install doors to provide smooth operation under normal conditions and to provide reliable operation under pressurized-hoistway conditions.
2. Install hoistway doors in such a manner that air leakage is minimized under pressurized-hoistway conditions.

H. WELDED CONSTRUCTION: Provide welded connections for installation of elevator work where bolted connections are not required for subsequent removal or for normal operation, adjustment, inspection, maintenance and replacement of worn parts.

1. Comply with standards of AWS D1.1 for workmanship and for qualifications of welding operators.

I. ELECTRICAL WORK:
Requirements specific to elevators include:

1. Marking each component, including but not limited to relays, switches, timers, fuses and overload devices, with permanent identification that corresponds with the nomenclature of the wiring diagrams and the operations and maintenance manuals specified in paragraphs 1.02.A.5 and 1.02.A.7 of this section.

2. Heat shrink labeling of wires.
3. Terminate all field wiring at each control cabinet on terminal strips suitable for the use. Field wiring shall not terminate on the studs of relays or other devices and equipment.
4. Communication outlet for intercom and data outlet for controller.

J. COORDINATION: Coordinate elevator work with work of other trades for proper time and sequence to avoid construction delays.

1. Use benchmarks, lines and levels to ensure dimensional coordination of the work.
2. Coordinate installation of hoistway entrances with installation of elevator guide rails, for accurate alignment of entrances with cars.
3. Where possible, delay final adjustment of sills and doors until car is operable in shaft.
4. Reduce clearances to minimum, safe, workable dimension at each landing.
5. Coordinate the following often overlooked items with other divisions:

   a. Hoistway ledge cants or screening for all exposed ledges inside the hoistway deeper than 2 inches
   b. Provide pit ladders for hoistways without walk-in pits.
   c. Elevator pit sumps and sump pumps
   d. Fire sprinklers for elevator machine rooms, pits, and tops of hoistways in accordance with Seattle DPD Director's Rule 7-2014. Provide shunt trip devices for disconnection of elevator power when sprinklers are required for elevator machine rooms.
   e. Appropriate lighting in the elevator pit, cab and elevator machine room. Provide a minimum of two light fixtures inside the elevator cab.
   f. Permanent non-combustible access stairs or ladders for elevator machine rooms and machinery spaces
   g. Provide GFCI receptacles in the elevator machine rooms, secondary sheave platforms, cars, and pits.
   h. Hoistway venting, elevator lobbies or hoistway pressurization
   i. Smoke detectors for elevator lobbies, elevator machine room and tops of hoistways for elevator firefighter service as required by the Seattle Fire Department, University Environmental Health and Safety Department, State of Washington Department of Labor and Industries Elevator Inspection Division and Seattle Department of Planning and Development. Coordinate zoning and fire alarm control panel requirements with the University Signal Shop.
   j. Only elevator and directly related equipment are allowed in elevator machine rooms, and hoistways.
   k. 7-foot minimum clear headroom in elevator machine rooms
   l. Machine rooms are required by Labor & Industries Dept. to be below 100 degrees. Provide mechanical cooling and consider a reflective roof coating at machine room to maintain temperature below 100 degrees. Provide an analysis to confirm performance.

K. SOUND ISOLATION: Mount rotating and vibrating elevator equipment and components on vibration-absorption mounts, designed to effectively prevent transmission of vibrations to structure, and thereby eliminate sources of structure-borne noise from elevator system.

L. LUBRICATION: Lubricate operating parts of systems, including ropes, if any, as recommended by manufacturers.

3.02 FIELD QUALITY CONTROL

A. COMPLIANCE TESTING: Upon nominal completion of each elevator installation, and before permitting use of elevator (either temporary or permanent), perform acceptance tests as required and recommended by Code and governing regulations or agencies.

1. Advise Contractor, Owner, Architect, and inspection departments of governing agencies, in advance, of dates and times tests are to be performed on elevators.
2. Advise Contractor, Owner, and Architect, in advance, of dates and times for inspections by governing agencies.
3. University Elevator Shop personnel shall be notified in advance of these tests, and shall be given ample opportunity to be present.

B. ACCEPTANCE TESTS: Conduct operational test of each car within two weeks of issue of the permanent operating certificate. Schedule an Elevator Shop observer with not less than one week's notice.

1. Running test: Load each elevator to its rated capacity and operate continuously for 30 minutes over its full travel distance, stopping at each level and proceeding immediately to the next.
    a. Record temperature rise of motor during 30-minute test period.
    b. Record speed up and down and leveling relative to landing sills at the end of the period.
    c. Requirements are as follows:
        i. Motor temperature rise within manufacturer's tolerances
        ii. Speed within 10% of specified speed
        iii. Leveling within ± 3/8 inch. Record failures of elevator to perform as required.
2. Power quality tests: Load each elevator to its rated capacity, and conduct tests of each elevator as follows:
    a. Measure voltage, current, total voltage harmonic distortion, total current harmonic distortion at the elevator disconnect in the machine room.
        i. Express voltage and current distortion as percentages of the fundamental.
    b. Test two conditions with each elevator:
        i. Elevators of the group turned off
        ii. The subject elevator operated at rated speed in the up direction, with all other elevators of the group turned off
3. When a hoist motor is replaced and prior to final coupling to gearcase, align motor shaft with brake coupling to within 0.002 inches radial runout as measured by dial indicators on each half of the coupling. The dial indicator test shall be witnessed by a

representative of the University Elevator shop. Notify the University Elevator Shop Supervisor at least 2 working days in advance to schedule the dial indicator test.

4. Provide copy of 5-year Safety Test to UW Elevator Shop and State of Washington Department of Labor and Industries.

C. PROTECTION: At time of final completion of elevator work (or portion thereof), provide suitable protective coverings, barriers, devices, signs or such other methods or procedures to protect elevator work from damage or deterioration. Maintain protective measures throughout remainder of construction period. Repair or replace, to the Owner's satisfaction, any components worn significantly or damaged before the Owner obtains beneficial use.

3.03 INSTRUCTION AND MAINTENANCE

A. Instruct Owner’s personnel in proper use, operations and maintenance of elevators.

1. Instruction shall be directed to an audience of experienced elevator mechanics.
2. Review emergency provisions, including emergency access and procedures to be followed at time of failure in operation.
3. Train Owner’s personnel in use of fault diagnosis and reprogramming hardware and software.
4. Provide 2 sessions, 6 hours in length, of classroom and machine room training for UW Elevator Shop personnel or pay for tuition for 2 UW Elevator Shop personnel to attend the factory training school of the controller manufacturer.
5. Training to be completed or training school tuition paid prior to application for substantial completion payment.

B. Provide table(s) of floor locator settings from the final adjustment, including acceleration and deceleration settings.

3.04 CONDITIONS PRECEDENT TO FINAL ACCEPTANCE

A. Instructions to operators: Instruction of the designated employees of the Owner in the operation and care of equipment and systems shall have been completed.

B. Code compliance: All code compliance tests shall have been performed and acceptance certified by the authorities having jurisdiction and permanent elevator operating permit issued to the University.

C. Acceptance tests: All acceptance tests shall have been completed and compliance certified by the University’s Elevator Shop.

D. Submittal of maintenance manuals: All manuals shall have been submitted as provided in Section 1.02 and approved by the University’s Elevator Shop.

E. Submittal of construction record drawings: Construction drawings of the work shall have been marked to show changes and actual installation conditions, sufficient to form a complete record for Owner’s purposes. Give particular attention to work which will be concealed and difficult to measure and record at a later date, particularly items which require servicing or replacement during the life of the projects, such as valves, traps, dampers, etc. Site utilities drawings shall indicate exact locations and elevations of pipe and utilities.

F. Final check: Make a final check of each elevator operation, with Owner's personnel present and just prior to date of substantial completion to determine that control systems and operating devices are functioning properly. Any and all damage and/or significant wear shall have been repaired.
G. Cleaning: The work site shall be clean. Clear away all debris, surplus materials, etc., resulting from work or operations, leaving the job and equipment furnished in a clean, first-class condition.
H. Punchlist: All items on the punchlist shall be completed to the satisfaction of the Owner and the Engineer.

Spare parts: Spare parts shall be delivered and accepted by the University Elevator Shop and construction office in accordance with Section 1.07.

Utility Tunnels, Trenches and Manholes

The mechanical and electrical services in the Seattle Campus are distributed in a network of underground trenches and arched tunnels.

("tunnel", hereafter, applies to both "trenches" and "tunnels").

A. DESIGN AND CONSTRUCTION REQUIREMENTS

General

1. Submit tunnel network addition/alteration proposal to Engineering Services for review and approval.
2. Indicate access aisle ways in tunnels and manholes on all plans and sections. Provide unobstructed access aisle ways.
3. Design utility tunnels and trenches in accordance with American Concrete Institute (ACI) standards.
4. Do not install City water, gas, sewer, or storm drain piping inside utility tunnels.

Alignment and Grade

1. Tunnel work generally consists of extensions of the existing tunnel system. Therefore, the general elevations are predetermined.
2. Provide a uniform tunnel slope between manholes.
3. Avoid grade interference with future building construction.

Drainage

1. Provide a drainage sump at the lowest level of all manholes and as required at intermediate points between manholes.
2. Provide a line of open joint or perforated drain tile between sumps. Locate drain tile below and parallel to the tunnel floor slab.
3. Pitch tunnel floor slab transversely to the piping side of the tunnel.

Manholes

1. Design and locate manholes to provide access for equipment removal and the installation of future equipment.
2. Do not locate equipment access openings and ventilation shafts in roadways or sidewalks.
3. Size manholes for equipment access to allow the entry or removal of the largest item; e.g. clearance for electrical feeder bend radius or 20-foot lengths of pipe.
4. Manhole openings to be made of precast concrete panels with recessed lifting eyes. Cover the panels with a water-proof membrane after installation.

5. Locate the top of the equipment access opening at a depth for convenient accessibility and to allow landscaping over; generally four feet. Slope the top slightly for water run-off.
6. In certain cases, where a utility trench is located near the grade, equipment openings may be required in the trench roof. At these locations, form the roof slab for removable precast concrete panels, with a waterproof membrane over. Slope precast roof panels to one side of the trench for water run-off.
7. Design ventilation shafts to prevent rain or surface water from entering the manhole. Shafts must offset from the manhole or provide a concrete pan below the shaft to catch any entering water. In either case, provide a floor drain and a curb to retain any water. Raise the surface opening six inches above grade.
8. Provide each manhole with a ventilation shaft to grade, approximately four feet square, with grating installed at grade and secured to allow removal by unfastening from below. Provide tunnel gratings that comply with AASHTO H20 loading criteria.
9. Provide galvanized, safety type, ladder rungs on one face of the manhole shaft to grade.
10. Provide landings in the manhole as required for equipment space and servicing. At landings provide removable open steel grating; suitable for all loads likely to be encountered during the life of the structure.
11. Provide stairs or 60° ship's ladders to connect the various levels. Vertical ladders are not acceptable without University approval.
12. Closely cut and neatly band all edges and openings in the grating.
13. Provide railings and kick plates on stairs and landings not adjacent to walls.
14. Do not rest pipe supports on gratings in manholes.
15. At the top of manhole sections to grade install galvanized, safety type, ladders for tunnel access through the top grating. Provide ladder extensions to provide safe access/egress.

Security

1. Provide ventilation openings at manholes fitted with an open grating with security locks bolted from below.
2. Secure tunnel portals at buildings with a six-inch concrete masonry block wall. Provide access by means of a 2'-0" x 6'-0" x1-3/4" hollow metal door fitted for pin tumbler locking mechanism (lock cylinder is furnished by the University). Sleeve openings for piping and cabling.

Construction

1. It is extremely important that tunnels be of watertight construction. Provide reinforced concrete construction for tunnels and manholes. Carefully prepare concrete specifications and construction details to insure a watertight tunnel.
2. For cast in place concrete conform to requirements of ASTM C-150 for Portland Cement.
3. For cast in place concrete conform to ASTM A-15 and A-305 for concrete reinforcing.
4. For cast in place concrete conform to the requirements of ASTM C33 for sand.
5. For prefabricated concrete provide steel reinforced concrete in conformance with ACI standards.
6. Provide water stops at all joints and keyways. Take special care to assure watertight joints at connections to existing construction.

7. Provide waterproof membranes over access panels, and elsewhere, if ground water is suspected. Apply damp-proofing to exterior wall and roof surfaces of trenches and manholes.
8. Fasten mechanical and electrical supports to embedded inserts and plates as noted hereinafter.
9. Do not use explosives in excavation.
10. Provide tunnel tolerances not to exceed the following:

Plumb	¼ inch in 12 feet
Surface Deviation	1/8 inch in 10 feet
Tunnel Variation from Line	¼ inch in 50 feet
Manhole variation from Line	¼ inch in 12 feet
Cross sectional variation in thickness	6 inch thick slab and under – minus 1/8 inch, plus ¼ inch. Over 6 inch thick slab - minus 1/8 inch, plus 1/2 inch.

Embedded Items

1. Provide flush mounted welding plates for anchorage of piping support structures. Locate at all tunnel deflection points, tunnel junctures with manholes or buildings and such intermediate points as required.
2. Provide cast metal inserts for piping support structures. Pipe support structures are at 12'-0" centers, in general; closer spacing as required for proper pipe alignment. Provide inserts set with the long dimension horizontal for adjustment.
3. Provide Unistrut No.6 260, or equal, for electrical tray support brackets; at five foot centers.

B. MECHANICAL

Utility tunnel piping is the main artery of the University mechanical systems. Any disruption in the systems affects the normal operation of the campus. Therefore, these systems must be designed and constructed for longevity and low maintenance.

Mechanical Drawings

1. Provide design details on drawings at a scale not less than 3/8" = 1'-0".
2. Provide details for each manhole to show the routing of all piping and location of all equipment.
3. Provide piping and equipment layout in detailed tunnel sections.
4. Include electrical work on drawings to indicate proper clearances and accessibility.

Piping General

1. For piping comply with the latest ASA Code for Pressure Piping, with welding operators qualified by either the National Certified Pipe Welding Bureau, American Petroleum Institute or ASME Boiler Codes.
2. Arrange and align piping to minimize pipe stress. For steel piping 2 inch size and larger provide welded construction.
3. For branch piping, welded tees are preferred. For connections to existing piping when the branch is smaller than the main, welding fittings or reinforced saddle welds may be used.
4. Miter welded joints are not acceptable.
5. Provide unions or flanged connections, with valves, where necessary for equipment isolation and removal.
6. Locate valves in the manholes for building services.
7. Do not use 3-1/2 inch and 5 inch size piping.
8. Provide slip type, internally guided, without base, welded end pattern, expansion joints. Adsco Type IS expansion joints are preferred. Provide joints with adequate traverse to provide a minimum movement of one inch over and above the computed expansion or contraction. Adjust expansion joints at the time of installation to take into account the tunnel temperature at the time of installation.
9. Provide insulation for steam and condensate piping in tunnels suitable for the temperature with no off-gassing or binder oxidation occurring near the pipe's operating temperature. Do not use fiberglass insulation on tunnel steam and condensate piping.
10. Insulation for CCW piping in tunnels shall be cellular glass or polyisocyanurate.
11. Provide metal jackets for all new piping insulation in the utility tunnels.

Anchors, Supports, Guides

1. Locate anchors in such a manner that "force couples are not be created. Locate branch take-offs near anchors.
2. Provide cast iron rollers with cast iron stand for bracket supported units; or cast iron roller with sockets for two hanger rods; sized to allow for insulation and pipe saddle. Provide bolts with lock nuts. Rod sizes as follows:

Pipe 2 inch size and smaller	3/8 inch
Pipe 2-1/2 inch through 4 inch size	½ inch
Pipe larger than 4 inch size	5/8 inch

3. Provide cast iron or steel alignment guides; concentric circle type, with an alignment spider centering the pipe; sized to allow the insulation to pass through the outer ring plus 1/2 inch clearance.

4. Provide welded angle iron frames, supported at floor, wall and roof at pipe support structures for rollers and alignment guides. Provide embedded inserts in walls and roof and drilled in anchors in the floor.
5. Provide raised and grouted floor supports off the floor to prevent rusting at the floor. Locate horizontal frame members at each support structure to minimize the use of shims.
6. Provide steel channel frames secured to the floor, wall and roof at pipe anchor structures. Provide embedded channel sections in the floor, wall, and roof. Provide continuous fillet welds (no tack-welds) on steel members.
7. Provide Star "Slug-in" compounded anchor bolts or equal at supports in existing construction and at floor supports in new construction. Provide galvanized or cadmium plated anchor bolts.
8. Provide drilled (not burned) holes for fastening.

STEAM & CONDENSATE SYSTEMS

Steam

1. Provide drip traps on steam piping at all changes of elevation, grade, or valves as required, with suitable drip legs and valved free blow connections no smaller than 3/4 inch size.
2. Seal weld screwed fittings on steam piping from the main to the first valve.

Condensate

<u>Flashing and Returning of High Pressure Steam (30 to 185 psig)</u>

1. Discharge high pressure traps as follows (in the order of preference):
   a. To lower pressure 15 psig mains
   b. To building flash tanks
   c. To tunnel high pressure drip piping
2. Provide inverted bucket type traps with replaceable seats and air bypass; 3/4 inch minimum size.
3. Provide gate valves at trap connections for isolation, stainless steel strainer with 1/16 inch perforations and swing check valve at discharge.

<u>Returning of Low Pressure Steam (15 psig or less)</u>

1. Discharge low pressure traps to gravity condensate return mains where possible, or to building condensate receivers.
2. Provide float type traps with integral thermostatic air bypass; fully repairable.

Compressed Air

1. Provide float traps at low points to drain condensation; with shut off valves and strainers.

Central Cooling Water System

1. Provide expansion joints with guides allowing full insulation and continuous vapor barrier jacket.
2. Central cooling water system pressure varies at different campus Locations. Obtain operating pressures at specific locations prior to the design for piping modifications.

C. ELECTRICAL

Electrical Drawings

1. The requirements of other electrical sections are applicable except for modifications as stated herein.
2. Experience has shown that proper electrical installations in tunnels and manholes can only be achieved when detail design drawings are provided at a scale of not less than 3/8" = 1'-0". Cables should be shown double line, with the minimal bending radius not exceeded. Cables less than one inch diameter may be shown with one line.
3. A sufficient number of details must be provided for each manhole to clearly show the routing of all cables and the proper location of all equipment.
4. Provide detailed tunnel sections for each variation of conditions.
5. Sufficient mechanical work should be shown to indicate proper clearances and accessibility.

Electrical Cables

1. The various electrical utility systems owned and operated by the University have been described in other electrical sections. The electrical cables required in the tunnels to implement these systems are herewith indicated with designation of particulars.
2. The following specifications for the various electrical utility cables carried in the University tunnel system are presented as a guide for the minimum requirements.

15 KV CABLE

1. Three conductor 15 KV cable, 500 MCM or #2/0, for grounded neutral service.

5 KV CABLE

1. Cable for 4.16 KV systems shall be rated for 5 KV and shall conform to the requirements for 15 KV cable except as noted herein.
2. Clock and Program Cable.
3. IPCEA Standard, 6-conductor, No. 12 AWG wires, plastic insulated with outer plastic jacket; insulation thickness, 0.030 inch on wires and 0.060 inch outer jacket.
4. Conductors shall be colored as follows: Black, white with yellow tracer, red, green, orange, and blue.

FIRE ALARM CABLE

1. IPCEA Standard, 6-conductor or 12 conductor as programmed,
2. No. 14G wires, plastic insulated with outer plastic jacket; insulation thickness, 0.030 inch on wires, 0.045 inch for 6- conductor cable outer jacket and 0.060 inch for 12-conductor cable outer jacket.
3. Color coding shall be as follows: Black, white, red, green, orange, and blue, for 6-conductor cable; 12-conductor cable, two sets of conductors with the foregoing colors, one set with tracer.

Cable Trays

1. Cable trays are used in the tunnels and manholes, and elsewhere as indicated in other Electrical sections, for carrying electric cables for utility systems.
2. Cable trays shall be galvanized sheet steel of the basket type construction. Manufacturer: Type "B" Globe Cable-Strut or Type "A", Husky Ventrib, SH series.
3. Cable trays shall be 9 inch wide size in tunnels and 12 inch wide size in manholes.
4. Ells and reducing fittings for cable trays shall be provided as shown on the Standard Drawings. Standard fittings shall be modified as required to suit the layouts shown. Reducing fittings shall be provided with a smooth transition; abrupt transitions are not allowed. Changes in elevation shall be made with standard fittings, modified where necessary to suit, or a special fitting shall be provided, of the same material, fabricated at a sheet metal shop. Connections to existing cable trays of a different type and/or dimension shall be provided with a special fitting of galvanized steel fabricated in a sheet metal shop.
5. Cable tray support brackets shall be Husky "VBK" series or equal with slotted holes on top for securing embedded formed metal inserts in the tunnel and manhole walls. Support brackets shall be galvanized steel and shall not project beyond the front edge of the tray.
6. The necessary bolts, nuts, Washers, etc., required for cable tray installation shall be galvanized steel or a material that is rust proof; shall be the size and type as shown on the Standard Drawings and as recommended or furnished by the manufacturer.
7. Install cable trays as shown on the Standard Drawings unless otherwise directed. It is intended that all cable tray installations, including special and modified fittings, reflect a neat and truly workmanlike job.
8. All cable trays carrying 4.16 KV and 13.8 KV cables shall be provided with a liner consisting of 1/4 inch thick non-asbestos sheet completely covering the bottom of the tray. Provide a single non-asbestos sheet cut to neatly fit the contour of the tray bottom at all fittings. Small individual pieces fitted together are not allowed. The installation of non-asbestos liners in high voltage cable trays is to afford protection to adjacent cables in the event of a fault or damage to a high voltage cable.
9. In the interest of the utmost in service reliability and safety, provide only one high voltage cable in any individual cable tray unless otherwise directed. Alarm and signal cables, such as supervisory, fire alarm and clock and program, may be carried in a common tray.
10. Cable trays shall be labeled for identification; such as 13,800 volts, 4160 volts, alarm and signaling, etc. Labeling consists of ¾ inch high black stencil letters on side of tray. Provide labeling at each manhole and at 100 foot intervals in tunnels.

Cable Clamps

1. Frequently it is necessary to run cables vertically in manholes from one elevation to another. Cable clamps shall be used for supporting cables in such installations and at all other locations where cable trays cannot be used.
2. In general, cable clamps shall be provided on 4 foot centers. They may be fastened to inserts spaced on 5 foot centers in tunnel walls, where they are available.
3. Cable clamps shall be constructed of close-grained maple hardwood impregnated with paraffin to a depth of 1/16 inch minimum after finishing. They shall be rectangular, two-piece, drilled for

anchor bolts and for cable; shall be Unistrut series U-159 to 166. The cable hole shall be exactly fitted to the cable outside diameter.

Cable Splices and Terminations

1. Stress relief cones shall be provided on all 15 KV cable splices and potheads and shall be in strict accordance with the manufacturer's instructions. Stress relief cones are not required for cables used on lower voltage systems on the campus.
2. Interlocked armor tie cables (480 volts) shall be terminated with a fitting specifically designed for jacketed armor cable; such as OZ Type "SPK" series. Connections to equipment shall be with solderless lugs.
3. Splicing and termination of high voltage power cables must be done by qualified persons specializing in this art. All work of this type will be supervised by University personnel. The UW will provide “hi-pot” testing on all cable systems including splices and terminations and the tests must pass I.P.C.E.A. and N.E.M.A. standards.

Grounding

1. Grounding shall be provided for electrical equipment in tunnels and man- holes. Exposed, non-current carrying metal parts of all fixed electrical equipment shall be grounded. Items to be grounded shall include but not be limited to metallic cable trays, cable armor, terminal cabinets, sectionalizing switches, potheads, splicing fittings, metallic raceway systems, panel boards, lighting fixtures, receptacles, etc.
2. Grounds shall be provided with ground rods in each manhole located near the electrical side of the tunnel entries to the manhole. Rods shall be copperweld 3/4 inch diameter, not less than 8 feet long. Ground resistance should not exceed 25 ohms and should be measured by the contractor and witnessed by the engineer. Additional ground rods shall be provided to reduce the resistance if the allowable value is exceeded.
3. Grounding conductors shall comply with the National Electrical Code but in no case be less than 500KCM AWG bare stranded copper. Ground conductors shall be neatly surface mounted and supported at intervals not exceeding 4 feet.

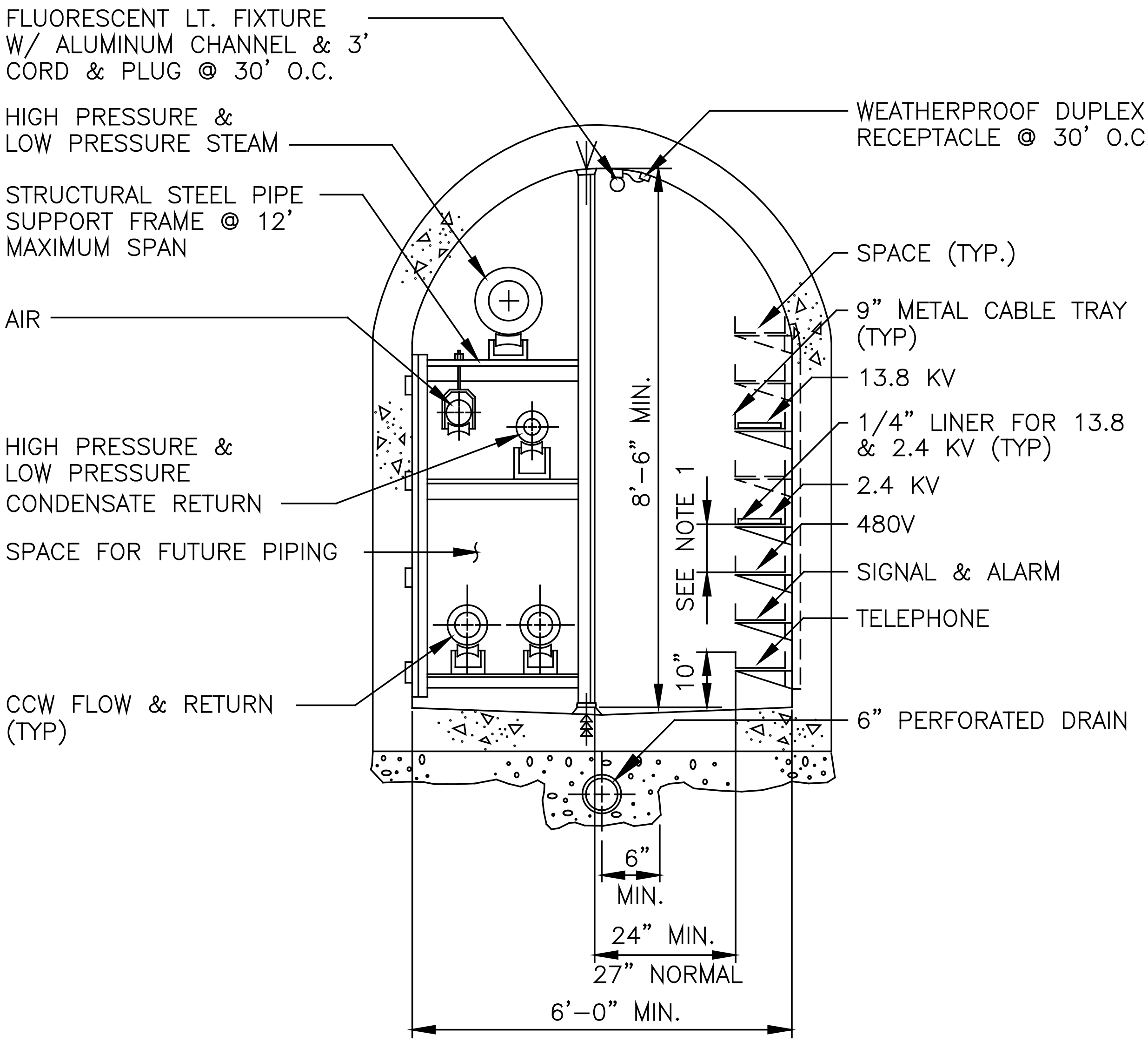
Terminal Cabinets

1. In general, provide terminal cabinets in all manholes for supervisory, fire alarm and clock and program systems. Cabinets shall be mounted so as to be readily accessible for maintenance and ease of wiring.
2. Terminal cabinets for the clock and program system and the fire alarm system shall be cast aluminum with barrier and with common hinged neoprene gasketed cover; OZ Type "YW-A" or equal. The barrier shall be removable and shall divide the cabinet equally into two sections. Cabinets shall be provided with mounting lugs. All hardware shall be stainless steel. Size shall be 12 inches long, 12 inches wide and 4 inches deep. Provide bosses tapped 1 inch NPT; 3 equally spaced on each 12 inch clear side and one on each 6 inch side of each section for a total of 10 bosses. Aluminum plugs shall be provided for all unused openings. A 20 point terminal block, rated 300 volts, shall be provided in each section of the cabinet, bolted to mounting buttons provided. Terminal blocks shall be Buchanan Catalog No. 625 or equal.

3. Cable connectors for connecting cables to the clock and program and fire alarm terminal cabinets shall be Crouse Hinds type CGB. Connectors shall be aluminum, 3/4 inch NPT, with tapered neoprene bushings sized to exactly fit the cable to be connected.

Tunnel and Manhole Lighting Systems

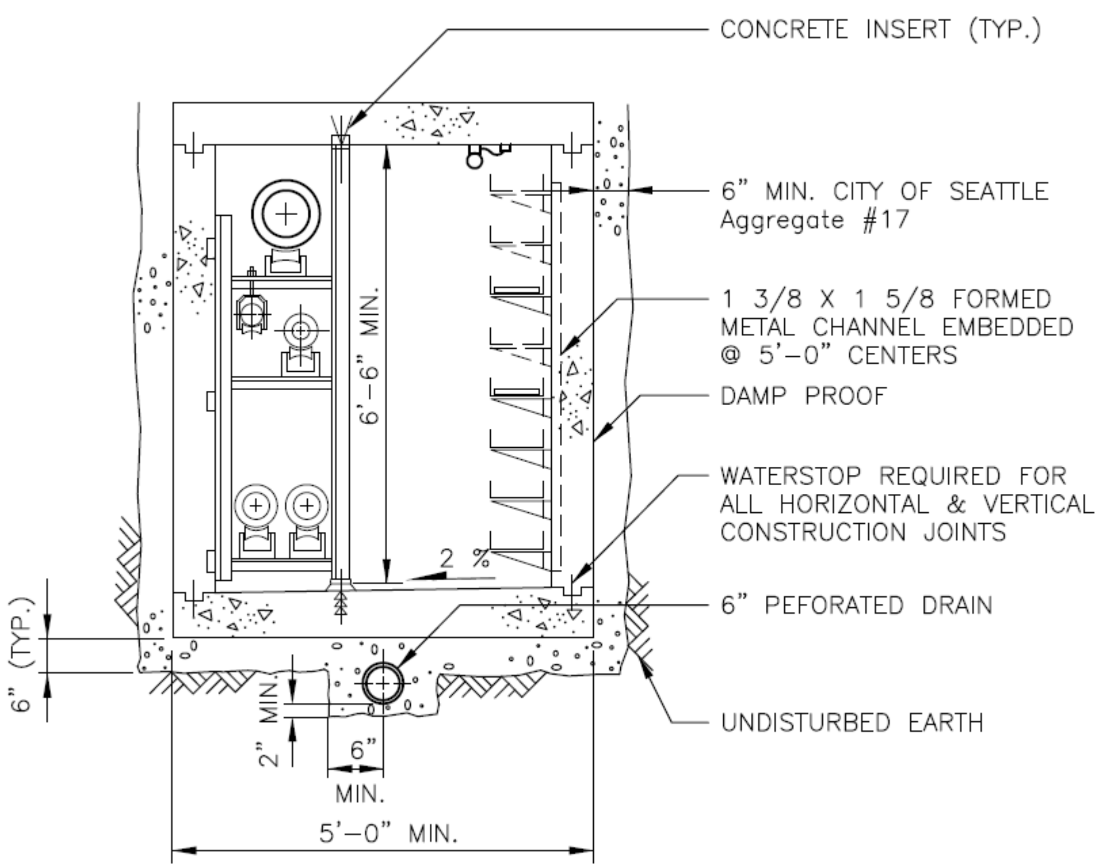
1. Normal tunnel lighting is intended to serve as pathway lighting and, as such, it is at a low average foot candle level. Lighting in manholes in addition to serving as pathway lighting should be sufficient for the operation of valves and switches. Provide adequate illumination must for stairways in manholes.
2. Lighting fixtures for use in manholes and tunnels shall be single lamp fluorescent strip units with 40 watt rapid start lamps; fixture channel constructed of aluminum. Fixtures shall be mounted at 30 foot intervals in tunnels, except if programmed othen1ise; surface mounted. Fixtures shall be mounted in manholes as required; surface mounted. Avoid mounting fixtures on removable sections of platforms. Fixtures for use in tunnels shall be provided with a 3 foot rubber cord with cap.
3. Wiring shall be with rigid conduit and type TRW conductors and shall be run exposed in tunnels and manholes. Wiring in manholes must be mounted to clear all removable sections of platforms.
4. A weatherproof duplex receptacle shall be provided at each fixture location in the tunnels. One receptacle shall serve as a power source for the lighting fixture. The other receptacle shall serve as a connection for hand tools. Provide adequate receptacles in manholes.
5. Tunnel lighting shall be wired with 3-way switches between manholes so that the lighting in a section of tunnel may be controlled by a switch in the manhole at either end of the section. Lighting in manholes shall be controlled by 3-way switches located at the top and bottom levels of the manhole. 4-way switches shall be provided at intermediate levels where tunnels connect.
6. Power for tunnel lighting shall be provided from the emergency system. If the emergency power system is not readily available, power shall be served from an emergency panel in a nearby building.
7. The applicable portions of other Electrical sections, shall apply to tunnel lighting systems.



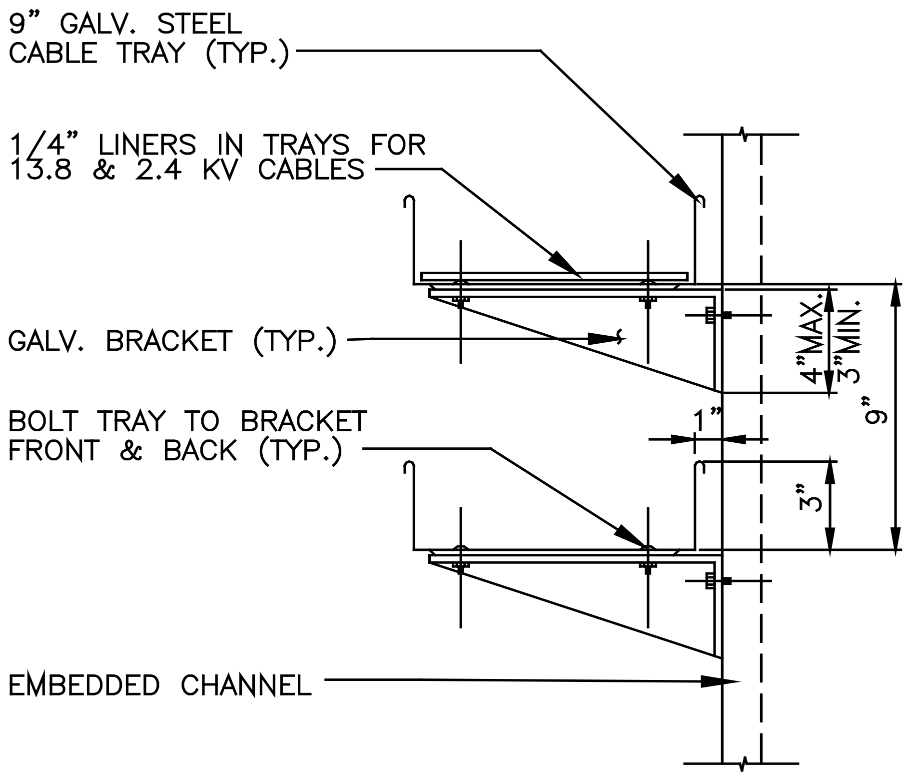
NOTES :

1. TRAY SPACING 9" TYPICAL EXCEPT AS DIRECTED BY THE UNIVERSITY

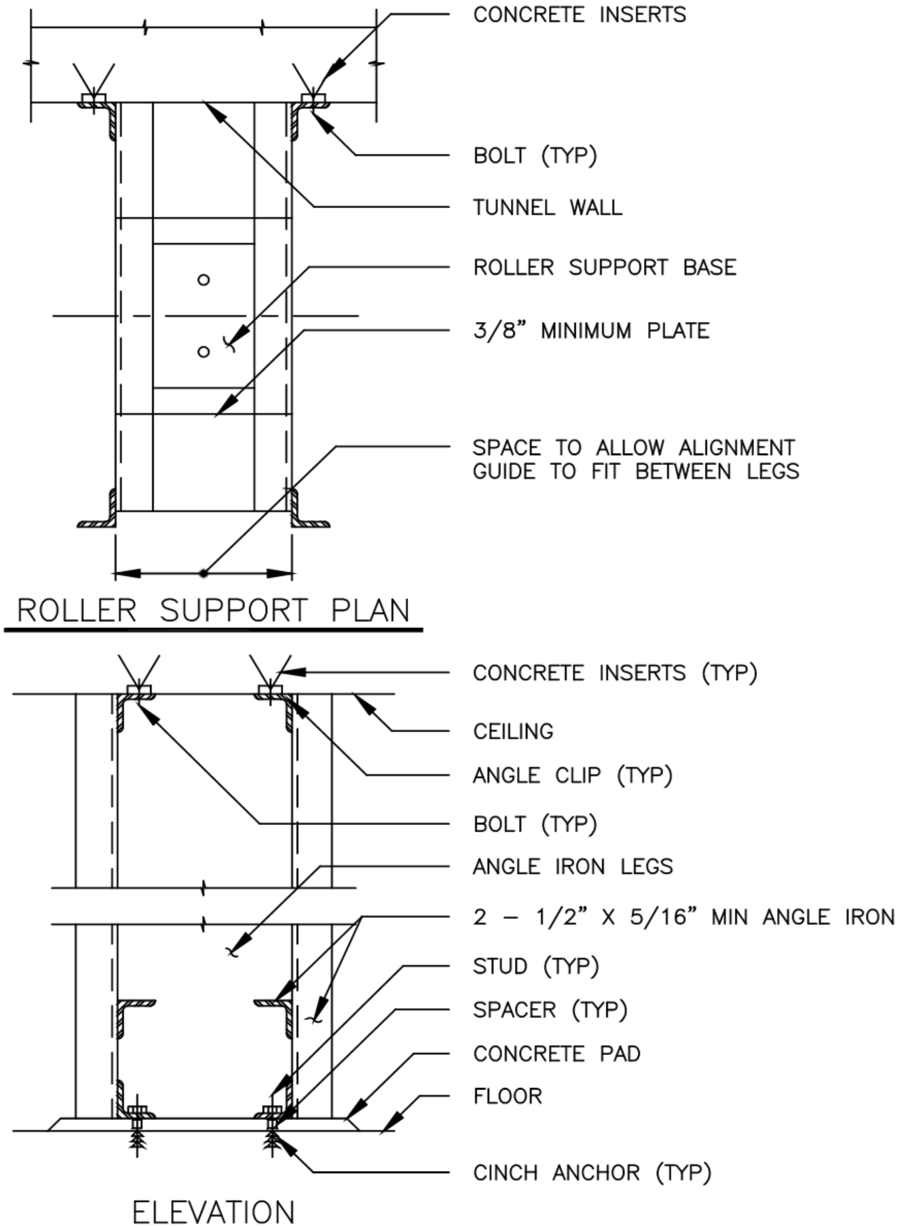
SD-M-20


CONCRETE INSERT (TYP.)
6" MIN. CITY OF SEATTLE Aggregate #17
1 3/8 X 1 5/8 FORMED METAL CHANNEL EMBEDDED @ 5'-0" CENTERS
DAMP PROOF
WATERSTOP REQUIRED FOR ALL HORIZONTAL & VERTICAL CONSTRUCTION JOINTS
6" PEFORATED DRAIN
UNDISTURBED EARTH
6'-6" MIN.
2 %
6" (TYP.)
2" MIN.
6" MIN.
5'-0" MIN.

SD-M-21


9" GALV. STEEL
CABLE TRAY (TYP.)
1/4" LINERS IN TRAYS FOR
13.8 & 2.4 KV CABLES
GALV. BRACKET (TYP.)
BOLT TRAY TO BRACKET
FRONT & BACK (TYP.)
EMBEDDED CHANNEL
4"MAX.
3"MIN.
9"
1"
3"

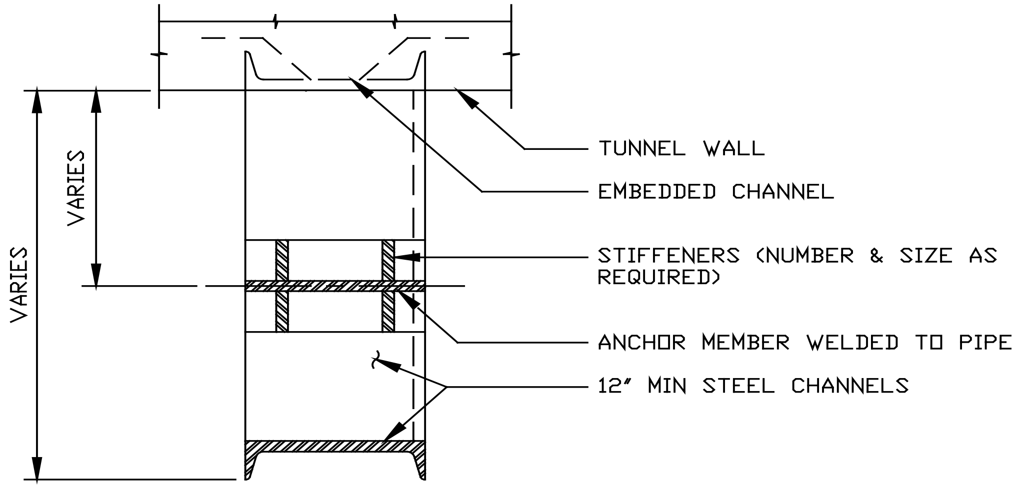
SD–E–152



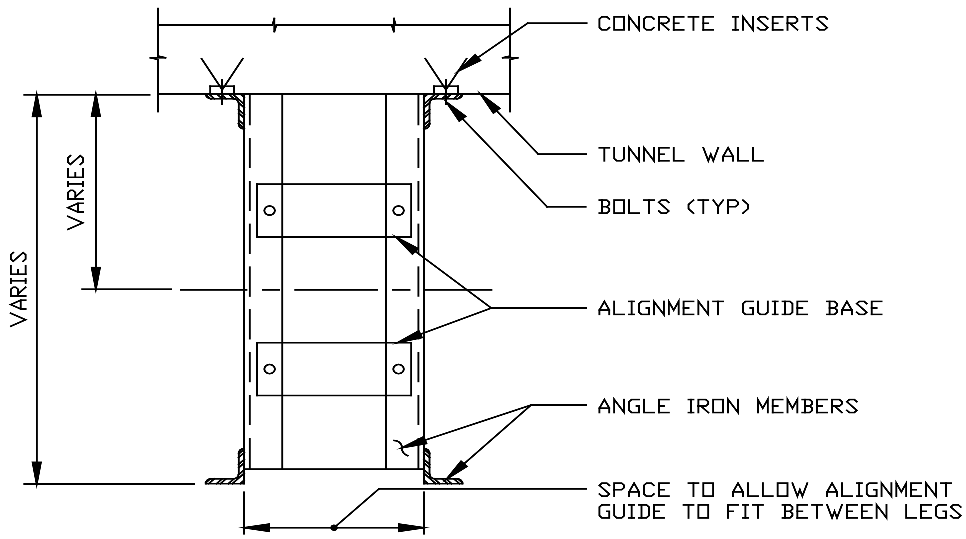
NOTES :

1. STRUCTURAL MEMBER SIZES & FASTENERS WILL VERY. SIZE ALL COMPONENTS FOR THE MAX POSSIBLE LOADS & FORCES TAKING IN ACCOUNT FUTURE PIPING.
2. WELD ALL JOINTS. FULL LENGTH WELDS (NO TACK WELD).
3. WITH TWO PIPES ON ONE SUPPORT MEMBER, SHIM AS REQUIRED WITH STEEL PLATES UNDER ONE ONLY.
4. PAINT ALL STEEL AFTER FABRICATION.

SD–M–25



PIPE ANCHOR PLAN



ALIGNMENT GUIDE PLAN

NOTES :

1. STRUCTURAL MEMBER SIZES & FASTENERS WILL VERY. SIZE ALL COMPONENTS FOR THE MAX POSSIBLE LOADS & FORCES TAKING IN ACCOUNT FUTURE PIPING.
2. WELD ALL JOINTS. FULL LENGTH WELDS (NO TACK WELD).
3. WITH TWO PIPES ON ONE SUPPORT MEMBER, SHIM AS REQUIRED WITH STEEL PLATES UNDER ONE ONLY.
4. PAINT ALL STEEL AFTER FABRICATION.

SD-M-24

Building Maintenance

A. Building Maintenance Services

1. General

This section applies to service areas and loading docks for new construction and major renovations.

Minimum requirements: Defined custodial area, service area and loading docks localized separation, collection, storage for recycling as well as centralized pick-up areas for recycling by floor or department. Provide for window washing and exterior façade maintenance and repair.

All buildings shall be designed for ease of access to all equipment for maintenance and replacement of components.

Maximum requirements: For larger buildings or buildings with highly technical programs provide a highly refined custodial area, service area and loading dock. Provide for the following typical services:

a. Custodial
b. Mail delivery and pick-up
c. Waste collection and storage
d. Recycling storage and pick-up
e. Physical Plant maintenance
f. Off-campus deliveries and pick-up with parking (UPS, Federal Express, etc.)
g. Local delivery and service with parking (food, beverages, etc.)
h. Equipment maintenance from off-campus vendors with parking
i. Bottled gas delivery, pick-up and storage
j. Large truck delivery of major equipment and/or apparatus
k. Special program related services and deliveries
l. Atypical waste and/or recyclable materials storage and pick-up. (Sharps, biological wastes, chemical wastes, hazardous wastes, etc.)
m. Building shall be designed to incorporate methods used on campus for window cleaning and exterior façade maintenances and repair. Coordinate with Custodial Services and Engineering Services.

2. Design Criteria

Service Area and Loading Dock

a. Separate pedestrian and vehicular traffic to eliminate conflicts and provide a safe environment for both uses. Provide for several major vehicles using the space simultaneously.
b. For wet laboratory areas in Science buildings, coordinate with client and EH&S for hazardous material storage and waste collection/bulking requirements.

c. Waste containers and compactors shall be easily accessible from building interior from at-grade or by ramps. Locate containers so waste can be emptied with a downward motion, not an upward motion.
d. University waste containers vary in size. Coordinate with Recycling and Solid Waste and client.
e. Provide a reinforced concrete slab for waste containers and compactors. Design 40-yard waste container slabs for 60,000 pound loading.
f. Coordinate compactor requirements with Recycling and Solid Waste.
g. Provide 60’ 0” in front of compactor for loading.
h. Locate away from outdoor air intakes to protect from contamination. Corrective air filtration systems (e.g. charcoal filters) are unacceptable.
i. Maneuvering space for vehicles shall be on-site and not in public areas. Parking area at the loading dock shall be level to insure the safety of the users.
j. Provide all-weather access with minimum clearance of 15’ 0”. Lifting of waste containers require minimum 16’ 6” clearance.
k. Maximum dock height shall be 4’ 0”. Provide heavy-duty spring loaded dock leveler(s) or scissors lift(s) that will accommodate truck bed heights from 2’ 0” to 4’ 0”. Provide continuous bumper strip.
l. If a forklift is required for the program, provide a 40’ 0” long x 5’ 0” wide ramp for dock access.
m. Minimum stall width shall be 10’ 0”. Provide minimum two stalls–one for 24” step van and one for city or long-haul vehicles.
n. Provide for waste that requires special handling: e.g. acceptable “landfill” waste, recyclable, compost, chemical, radiation, biological, sharps, etc.
o. For larger projects provide a recycling sorting room adjacent to the loading dock. Provide a 150 s.f. space in a secure area to protect from arson and vandals.
p. For buildings 25,000 g.s.f. and over provide a specifically designated service elevator.
q. Provide catch basins and/or trench drains and slope slab to drains to assure a water-free working area. Locate in accessible areas for maintenance.
r. Provide cold water hose bibb at all service areas and loading docks. At buildings with large containers and/or compactors, provide hot and cold water with a hose reel and sufficient hose length to reach the entire area.
s. Provide fire sprinklers.
t. Provide weather-resistant, industrial-quality light fixtures that will illuminate the area to a level that provides safety and security.
u. Provide GFIC, weather-resistant, 120 volt, 20 amp duplex outlets at the loading dock. Provide minimum of two and more as the program and size dictates. Compactors generally require 440 volt service; coordinate with manufacturer.
v. Service area walls shall be concrete or fully grouted CMU to resist abuse. Protect finished walls with curbs, bollards, railings and/or dock bumpers. Protect the wall behind the waste containers from damage caused by less-than-careful opening of lids.
w. Provide heavy-duty floor covering in adjacent building areas.
x. Recess or enclose all protruding elements where birds could roost. Seal flush all cracks, crevices and separations between materials to prevent birds roosting.
y. Screen area from view in a manner that will not compromise the function of the area. Do not locate landscaping that requires regular maintenance in the service area.

3. Mailing Services

a. Mail, campus generated and from off campus, is delivered by Mailing Services to University owned buildings on and off campus. The type of facilities required depend on the size of the building population and how many departments are housed within a building.
b. Minimum requirements: Provide a Mail Cabinet in a public area, i.e. reception area. Coordinate size with Mailing Services. https://finance.uw.edu/c2/mailing/contact-us Minimum size is Type A cabinet. (See SD-A-46) Cabinet shall be keyed to Mailing Services key only. Do not key to building system.
c. For buildings with a large population or with several departments provide a Mail Room located on the ground floor. Minimum size shall be 10'-0" by 10'-0". Locate within 50'-0" from a loading dock or for buildings without a loading dock, 50'-0" from the nearest entry accessible by a Mailing Services vehicle. Provide adequate lighting, ventilation and heat. Provide cooling if provided in building. The Mail Room shall be keyed to allow Fire and Police personnel access in event of emergencies.
d. Do not locate the Mail Cabinet or Mail Room where access requires the use of stairs. Stairs are not used by Mailing Services personnel to prevent injuries caused by carrying, pushing or pulling deliveries up and down stairs.
e. If Mail Service is affected by construction projects, service shall be maintained to those areas unaffected by construction. Mail service may be delivered to an adjacent building if arranged with Mailing Services.

4. Custodial Area

Four types of custodial areas are required

a. Bulk Space

  i. Provide in major buildings and renovations (25,000 s.f. or larger).
  ii. Provide 200 s.f. room near loading dock for storage of case paper products and drum chemicals.
  iii. Provide a pair of out-swinging doors, 60 inches wide, minimum.
  iv. Provide center floor drain and mechanical exhaust with 12 air changes per hour.
  v. Provide 16-inch deep adjustable shelving with heavy duty brackets to the ceiling, full length at the longest wall.
  vi. Provide an electrical outlet with GFCI

b. Primary Working Custodial Closet

  i. Provide 120 s.f. (10'. x 12') room at one per 25,000 to 30,000 s.f. of floor area assigned to each custodian.
  ii. Provide an out-swinging door, 42 inches wide, minimum.
  iii. Provide center floor drain, floor-mounted custodial sink with splash shield located adjacent to door and mechanical exhaust with 12 air changes per hour.
  iv. Provide mop hanger/drying rack adjacent to sink by Bobrick or approved substitution.
  v. Provide 16-inch deep adjustable shelving with heavy duty brackets to the ceiling, full length at the longest wall.
  vi. Provide an electrical outlet with GFCI
  vii. Do not locate within restrooms.
  viii. Do not locate pipe chases or utility panels within closet.

c. Supplemental Working Closets

i. Provide 70 to 80 s.f. (10' x 7' or 8') per floor without a Primary Working Closet. In major buildings and renovations alternate with Primary Working Closets depending on the number of floors and the area requirements for Primary spaces. If Bulk Storage space is not provided Supplemental Working Closets are required.
ii. Provide an out-swinging door, 42 inches wide.
iii. Provide center floor drain, floor mounted custodial sink with splash shield located adjacent to door and mechanical exhaust with 12 air changes per hour.
iv. Provide mop hanger/drying rack adjacent to sink by Bobrick or approved substitution.
v. Provide 16-inch deep adjustable shelving with heavy duty brackets to the ceiling, full length at the longest wall.
vi. Provide an electrical outlet with GFCI
vii. Do not locate within restrooms.
viii. Do not locate pipe chases or utility panels within closet.

d. Custodial Dispatch Office

i. Provide for specific projects. Coordinate with Project Manager and Custodial Services.

e. Miscellaneous Building Utility Services

i. Provide electrical outlets per Electrical-Wiring Devices at corridors and stairwells every 50 feet. Mounting height (36"). Provide circuits separate from offices, labs or other building uses.
ii. Provide electrical outlets per Electrical-Wiring Devices at one side of entrances and at stair landings.
iii. Provide weatherproof electrical outlets and hose bibs at building parapets at 75 ft. o.c. for maintenance and window washing. Provide separate circuits for outlets.
iv. Provide depressed transitional walk-off areas at building entrances to collect water and dirt to reduce floor covering wear and maintenance.
v. All storage rooms for recycling bins and chemical cleaning products shall have non-recirculating exhaust systems to minimize contamination of adjacent rooms.
vi. Provide localized drains plumbed for appropriate disposal of liquid waste in spaces where water and chemical concentrate mixing occurs.

CAAMS

A. CAAMS – Campus Automated Access Management System

Basis of Design

The section applies to the design, rough-in, and installation of automated access control systems for University facilities. These systems control access at building entrances and at the doors that lead into specified controlled zones within a building.

Background

The University of Washington has created a Campus Automated Access Management System (CAAMS) that is a centralized access control system for all buildings on campus. CAAMS is a standardized system for gaining access to University facilities using an access card rather than a brass key.

The primary functions of CAAMS are:

1. To allow access privileges for each building user to be custom tailored.
2. To allow access privileges to be quickly cancelled in case an access card is lost or stolen.
3. To allow building access activities to be monitored and documented.
4. To allow doors to be automatically locked and unlocked according to a pre-established time schedule.

CAAMS is intended as an automated access control system and not as a building “security system”.

Scope

This section establishes guidelines for the design and installation of CAAMS in all new buildings and major remodel projects.

Programming

CAAMS is used to control access at all exterior (zone) doors and at certain interior access control zones, such as computer labs, office suites, audio/visual equipment rooms, and other zones with specific access concerns. To facilitate CAAMS, certain programming issues need consideration during design. These include:

1. Physical separation between public/non-public areas.
2. Physical separation between different departments/operating units in the same building.
3. Access to the public after hours.
4. Conflicts between access control and life safety, i.e., egress, latching of fire doors.
5. Conflicts between access control and ADA accessibility.

At a minimum, all exterior doors of University buildings shall be controlled and/or monitored by CAAMS. Specific interior doors to be controlled shall be identified during conferencing with user representatives from the departments who will occupy the building.

Design Criteria

CAAMS equipment at each building consists of central control equipment within the building as well as specific devices at each door controlled by the system.

Central Control Equipment

The central control equipment is installed at a "CAAMS Backboard" which is located in a dedicated closet within the building. Each building controlled by CAAMS shall have at least one CAAMS backboard. Where CAAMS controlled doors are located on multiple floors of a building, a separate CAAMS backboard shall be provided on each floor. Each CAAMS backboard typically includes the following items:

1. Intelligent Controller.
2. Card Reader Interface Modules.
3. Input Modules.
4. Output Modules.
5. Power Supplies and related accessories.
6. Power Supply Network Interface
7. Network Switch.
8. Equipment Enclosures.

The specific quantity and types of equipment to be provided at each CAAMS Backboard shall be determined during the design phase based on the number and types of CAAMS doors to be controlled. Equipment shall be designed at 75% capacity to allow for future expansion.

(See drawing at end of section for typical arrangement of CAAMS Backboard.)

Door Devices

The types of devices provided at each door are determined by the access control function required. The four major access control functions and the devices required for each function are as follows:

1. CARD READER DOOR: Allows entry using access card, scheduled locking and unlocking, and door status monitoring. Devices required include:
   a. Multi-technology card reader.
   b. Door contact switch.
   c. REX (request to exit motion detector).
   d. Sounder.
   e. Electric lock or electric exit device.
   f. Power transfer hinge.
2. AUTO-LOCK DOOR: Allows scheduled locking and unlocking and door status monitoring. Devices required include:

a. Door contact switch.
b. REX (request to exit motion detector).
c. Sounder.
d. Electric lock or electric exit device.
e. Power transfer hinge.

3. EXIT-ONLY DOOR: Allows door status monitoring. Devices required include:

a. Door contact switch.
b. REX (request to exit motion detector).
c. Sounder.

4. EMERGENCY EXIT-ONLY DOOR: Allows door status monitoring, provides audible alarm when door is used. Devices required include:

a. Door contact switch.
b. Sounder or horn.

These door functions may be applied to single doors and pairs of doors, with or without center dividing mullions.

- Typical Card Reader Controlled Single Door
- Handicap Exit Device Card Reader Controlled Double Door
- Typical Exit Device Card Reader Controlled Double Door
- Typical Equipment Arrangement

Elevator Control

Where required, CAAMS may be used to control elevators. This function requires the installation of card readers at elevator hall call stations and/or in the elevator car itself. The use of elevator control also requires that special provisions be made within the elevator equipment itself to accommodate the CAAMS installation.

Space Requirements

There shall be at least one dedicated closet in each building for the installation of CAAMS related equipment. In multi-story buildings where CAAMS equipment is located above grade, there shall be a closet on each floor where CAAMS controlled doors are located. Each closet shall have a minimum dimension from the panel board(s) of 3' 0" clear. Minimum usable wall space for equipment shall be 6'-0" wide by 8'-0" high.

Each closet shall contain the following provisions:

1. One fire-retardant treated plywood "backboard" with minimum dimensions of 5' 6" wide x 7' 0" high.
2. Minimum of one 120V, 20A 4-plex electrical outlet on dedicated circuit.
3. Minimum of two Ethernet connection ports.

Design Assistance

The University CAAMS Manager will work with clients, project managers, and the University shops to incorporate the design of CAAMS into new construction and major renovation projects.

The CAAMS Manager should be notified of new projects as early as possible in the design process.

Architects and Engineers (A/Es) are required to engage the services of a University-approved CAAMS consultant to design the building's CAAMS. For the current University of Washington CAAMS consultant, contact UW Campus Engineering.

Interdisciplinary Coordination

The work of this section shall be closely coordinated with other members of the design team. Specific areas requiring coordination include, but are not limited to the following:

1. Electrical engineer: coordinate requirements for conduits, back boxes, cable trays, and electrical power.
2. Hardware consultant: coordinate requirements for electric lock hardware.
3. Architect: coordinate space requirements for CAAMS Backboards, preparation of doors and frames, and any special construction items needed (such as pedestals for card readers).
4. Elevator consultant: coordinate requirements for elevator travelling cable, card reader placement in elevator cars, and modification of elevator control equipment.
5. Telecommunications consultant: coordinate requirements for network connections at CAAMS Backboards.

Departmental Responsibilities

University departments who will be using CAAMS shall appoint designated representatives who will be responsible for managing CAAMS and coordinating access needs with other members of their department. These representatives shall receive training on CAAMS and act as CAAMS operator their department. At least two representatives shall be appointed; one that will serve as primary operator, and one that will serve as back-up operator.

Design Evaluation

The following information is required to evaluate the design:

1. <u>Programming Phase</u>: Statement of intent to use CAAMS, or to rough-in only for control of access to facility and/or portions of the facility. Identify unique access zones under either scenario. Determine relationships with University CAAMS consultant(s) and vendor(s).
2. <u>Schematic Design Phase</u>: Plan showing boundaries of access control zones. Outline specification identifying basic access control function for each zone. Locate and size CAAMS closets.
3. <u>Design Development Phase</u>: Plan drawing showing access control zones, the location of controlled doors and other wall openings, an elevation view of doors showing locations of CAAMS equipment and other hardware. Show location of CAAMS closets and draw elevation of CAAMS equipment backboards. Draft specification listing specific functions for each controlled opening (see opening "functions" above). List proposed products. Coordination with the hardware schedule. Note "points-of-connection" for power and signal. Prepare "sequence of operations" diagrams for each CAAMS function. Status Matrix.
4. <u>Contract Document Phase</u>: In addition to the DD requirements, prepare a schedule of doors and openings receiving CAAMS, listing all related equipment. Provide diagrams of conduit and

raceway systems, power supply, data circuits, and show “points of connection” between work by University forces and work by Contractor. Final specification for the system.

Construction Submittals

The following minimum submittals are required from the Contractor:

1. Refer to CAAMS standard specifications, Access Control System section.

Related Sections

1. Facilities Services Design Standard - Interior Doors
2. Facilities Services Design Standard - Exterior Doors
3. Facilities Services Design Standard - Finished Hardware
4. Environmental Health & Safety Design Guide - Fire Alarm System
5. Facilities Services Design Standard - Elevators
6. University of Washington CAAMS Manual
7. UW Technology Design Guide

Products, Materials and Equipment

1. The A/E shall work with University CAAMS Manager and the approved CAAMS consultant, designing each individual building system to insure system compatibility with University CAAMS. The A/E shall be responsible for the design of the complete system.
2. The A/E shall work closely with representatives from the individual University departments who will occupy the building to determine CAAMS requirements for interior doors.
3. Equipment furnished under this section may be by any manufacturer who is approved by CAAMS Manager prior to completion of Contract Documents. The A/E shall submit a list of proposed equipment and vendors to the CAAMS Manager for approval.
4. Refer to the attached standard specifications Access Control System section.
5. Specifications for CAAMS-related door hardware to be provided under Section 08 70 00.

Installation, Fabrication and Construction

1. Some equipment will be installed by University CAAMS vendor.
2. Design must clearly show “points of connection” between University and Contractor forces.
3. Refer to attached standard specifications section Access Control Systems and Details.

CAAMS – Standard Specifications

The following standard specifications are intended to be modified and included in the Contract Documents. Items to be modified should be done in consultation with the University Project Manager, Campus Engineering and CAAMS Manager.

A. CAAMS – Campus Automated Access Management System

SECTION 28 10 00 ACCESS CONTROL SYSTEM

PART 1 – GENERAL

1.01 SECTION CONTENTS

A. Building access control system including intelligent field panels, input modules, output modules, power supplies, communications devices, and related equipment.
B. Card readers, detection devices, request-to-exit devices, and related equipment.

1.02 RELATED SECTIONS

A. Division 1 – General Provisions.
B. Section 08 10 00 – Doors and Frames.
C. Section 08 40 00 – Entrances, Storefronts and Curtain Walls.
D. Section 08 70 00 – Hardware.
E. Section 14 20 00 – Elevators.
F. Section 26 00 00 – Electrical.

1.03 RELATED WORK PROVIDED IN OTHER SPECIFICATION SECTIONS

A. Unless noted otherwise, the following work is to be provided under other specification sections:

1. Electric door lock hardware.
2. Automatic door openers, including actuator buttons.
3. Door position switches on pedestrian doors.
4. Conduits, raceways, and electrical back boxes.
5. 120 VAC power wiring to power supplies.

1.04 BASIC DESCRIPTION OF SYSTEM

A. The University of Washington has an existing campus-wide access control system. This system is known as the “Campus Automated Access Management System” (CAAMS). Principal components of CAAMS are manufactured by Lenel, a unit of United Technologies Corporation.

B. In the interest of standardization and to permit centralized management and support, all new access control systems installed at the main University of Washington campus shall utilize equipment compatible with CAAMS and be connected as an extension to the existing access control system. The use of other types or brands of access control systems shall not be permitted at University of Washington facilities.
C. The access control system at each building shall consist of one or more "intelligent controllers" installed locally at the building. These intelligent controllers shall be installed at backboards located in designated closets within the building. Intelligent controllers shall be connected to existing CAAMS host computer via the University's TCP/IP network. Local host or server computers for CAAMS shall not be installed at individual building.
D. All card readers, detection devices, signaling devices, lock hardware and other such devices at building are to be wired to the nearest CAAMS backboard in the building. The maximum cable distance between device and backboard shall not exceed 500'.
E. Control and management of the building's access control system to be accomplished using a web-browser interface connected to the central CAAMS host computer via the University's TCP/IP network. A web-based user portal (CAAMS Terminal Server) is provided that allows authorized users to manage CAAMS for their building without needing to have special software on their computer. Remote or off-campus access shall be accomplished using Husky OnNet.

1.05 CONTRACTOR

A. The University of Washington has an exclusive purchase agreement with a security system contractor for all work related to the CAAMS. This contractor was selected using an open competitive bidding process which resulted in the award of an exclusive purchase agreement for the current contract period. The Contractor performing the work of this section shall be the security contractor who currently has the exclusive agreement with University of Washington.
B. For the current University of Washington CAAMS contractor, contact UW Campus Engineering.

1.06 SUBMITTALS

A. Provide submittals in accordance with Division 1.
B. Shop drawings
    1. Provide shop drawings showing equipment locations and routing of cables and wiring in conduits, raceways, and cable trays.
    2. Shop drawings shall indicate cable types and sizes, routing, splice and connection points, equipment locations, point numbers, and equipment addresses, and other such information.
    3. Shop drawing floor plans shall be prepared using a standard architectural scale. Preferable scale of floor plans for shop drawings shall be 1/8" = 1'. Smallest scale allowable for shop drawings shall be 1/16" = 1'.
    4. Approved shop drawings shall be used as plan for system installation.

C. Point-to-point wiring diagrams

1. Provide point-to-point wiring diagrams; indicating terminal-to-terminal connections between system components, type of connections, and other information necessary to make final terminations.
2. Point-to-point wiring diagrams may be included within shop drawings instead of as a separate submittal.

D. Product data

1. Provide product data submittals on all products proposed for use under this section.

1.07 FINAL ACCEPTANCE

A. After work is completed, and prior to requesting the Acceptance Test, Contractor shall conduct a final inspection and pre-test all equipment and system features. Contractor shall correct any deficiencies discovered as the result of the inspection and pre-test.

B. Contractor shall submit a request for the Acceptance Test in writing to the UW CAAMS Manager using an approved "Request for CAAMS Acceptance Test" form, a copy of which is provided on the second page following.

1. This request shall be submitted to UW CAAMS Manager no less than 21 days prior to the requested test date.
2. The request for Acceptance Test shall constitute a certification from Contractor that all work is complete and in compliance with the Contract Documents, all systems have been tested, and all corrections have been made.

C. Acceptance Test shall be scheduled during a period when the building is unoccupied and a complete system test can be accomplished.

D. Contractor shall provide the services of no fewer than 2 technicians to perform the Acceptance Test.

1. Technicians performing the Acceptance Test shall have been involved in the installation of this project and shall be thoroughly familiar with all aspects of the work.
2. Technicians shall be equipped with portable two-way radios for use during the test.

E. Contractor shall provide all ladders, tools, test equipment, and other facilities needed to accomplish the Acceptance Test.

F. During the Acceptance Test, Contractor shall demonstrate all equipment and system features to UW CAAMS Manager.

1. Contractor shall fully cooperate with the UW CAAMS Manager and provide assistance with the inspection and test.
2. Contractor shall remove and reinstall covers, open and restore wiring connections, operate equipment, and perform other reasonable work as requested by the UW CAAMS Manager.
3. The Acceptance Test shall be documented using an approved CAAMS Acceptance Test Checklist. An example is provided on the second page following. Contractor may use

alternative types of checklists and/or documentation methods as approved by the UW CAAMS Manager.

G. Any portions of the work found to be deficient or not in compliance with the Contract Documents will be rejected.

1. UW CAAMS Manager will prepare a list of any deficiencies observed during the Acceptance Test.
2. A copy of this list will be provided to the Contractor, who will promptly correct all deficiencies.

UNIVERSITY OF WASHINGTON
REQUEST FOR CAAMS ACCEPTANCE TEST

Building: ____

Contractor: _______________________________________

I hereby certify that:

1. The CAAMS installation at the above mentioned building is complete and has been provided in accordance with the Contract Documents.
2. That all systems and devices have been thoroughly pre-tested, and that all necessary corrections have been made.
3. That all project documentation, including Project Record Drawings, System Documentation, Panel Program Sheets and other such information, has been submitted in accordance with the Contract Documents.
4. That all systems have received final inspection and acceptance by the regulatory bodies having jurisdiction at the project location, and that copies of "signed-off" permits have been submitted in accordance with the Contract Documents.

I request that a CAAMS Acceptance Test be conducted

on the ______________ day of ____________________, 20_____.

By: ____

Title: ____

Company: ____

Date: ____

CAAMS Representative Signature:

Installing Contractor Project Manager Signature:

Construction Commissioning Agent Signature:

Test Date:

DRAWING DOOR NUMBER/ NAME	Onguard Programming Name	Commission Date:	Invalid Card Read? (Y, N, N/A)	Valid Card Read? (Y, N, N/A)	Force Open Alarm? (Y, N, N/A)	Held Open Alarm? (Y, N, N/A)	Tamper Alarm? (Y, N, N/A)	Sounder Operates when Door Held Too Long? (Y, N, N/A)	Sounder Operates On Door Force Alarm? (Y, N, N/A)	Valid Exit - No Alarm? (Y, N, N/A)	Entrance ADA Button Only Works When Door is Unlocked? (Y, N, N/A)	Exit ADA Always Works With No Alarms? (Y, N, N/A)	Does Door Close and Lock Securely?	Are Devices Installed Neatly and Accurately?	Labeling Completed? (Y, N, N/A)	Door Holders Release When Door Locks ? (Y, N, N/A)	COMMENTS:

Figure 1- Example of CAAMS Acceptance Test Checklist

1.08 PROJECT RECORD DRAWINGS

A. Submit project record drawings in accordance with Division 1.
B. The purpose of project record drawings is to provide factual information regarding all aspects of the access control system to allow for future service, modifications, and additions.
C. Project record drawings shall include documentation of all work, including the documentation of equipment, wiring, conduits, cable trays, and raceways that are related to the work but are provided under other sections.

   1. Contractor shall maintain the working set of project record drawings at the project site throughout the course of the work.
   2. The working set shall be updated on a daily basis as the work progresses.

D. Project record drawings shall accurately show the physical placement of the following:

   1. Equipment and devices
   2. Wire and cable runs
   3. Conduits, cable trays, and raceways
   4. Junction and pull box locations
   5. End-of-line resistor locations
   6. Interfaces to external equipment
   7. Connections to power and data circuits

E. Project record drawings shall show the physical placement of each device or conduit centerline, to be accurate to within 3 inches on scaled drawings.

   1. Show dimensions from finished walls or floors if location cannot be accurately portrayed by scale.
   2. Show, by symbol or note, the vertical location of the item ("under slab," "in ceiling space," "exposed," etc.)

F. Project record drawings shall show wire and cable runs, point and door numbers, tamper circuit configuration, panel/circuit breaker numbers from which equipment is powered, and splice points.

   1. Such information may be shown on the floor plans, or may be documented on separate Riser Diagrams that will supplement the floor plans.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Access control intelligent controllers, input modules, output modules and card readers shall be branded by Lenel and use Lenel part numbers. No substitutions are acceptable.
B. Other equipment shall be produced by the manufacturer or manufacturers indicated herein. No substitutions are acceptable.

2.02 INTELLIGENT SYSTEM CONTROLLER

A. Microprocessor-based intelligent controller provides complete local processing of access control transactions. Stores up to 500,000 cardholders in non-volatile flash memory. Supports up to 64 card reader controlled doors through use of card reader interface modules. On-board high-speed Ethernet 10/100Base-T upstream port for connection to central CAAMS server computer. 15 MB of available on-board, non-volatile flash memory.

B. Intelligent controller shall provide local processing for up to 16 different card formats, up to 32,000 access level permissions, 255 holidays, 255 time zones, and provide elevator control support for up to 128 floors.

C. Provide Lenel Model #LNL-3300. No substitutions are acceptable.

2.03 SINGLE-READER INTERFACE MODULE

A. Card reader interface module allows monitoring and control of one card reader controlled door. Provides one (1) card reader input, one (1) SPDT (Form C) output rated at 5 amperes, one SPDT (Form C) output rated at 1 ampere, two (2) general purpose supervised inputs, and (1) tamper input. Connects to intelligent controller using RS-485 data connection.

B. Provide Lenel Model #LNL-1300. No substitutions are acceptable.

2.04 DUAL-READER INTERFACE MODULE

A. Card reader interface module allows monitoring and control of two card reader controlled door. Provides two (2) card reader inputs, six (6) SPDT (Form C) outputs rated at 5 amperes, eight (8) general purpose supervised inputs, one (1) power status input, and (1) tamper input. Connects to intelligent controller using RS-485 data connection.

B. Provide Lenel Model #LNL-1320. No substitutions are acceptable.

2.05 INPUT CONTROL MODULE

A. Input control module provides sixteen (16) general purpose inputs, one (1) power status input, and (1) tamper input. General purpose inputs programmable as supervised or unsupervised. Two (2) SPDT (Form C) outputs rated at 5 amperes. Connects to intelligent controller using RS-485 data connection.

B. Provide Lenel Model #LNL-1100. No substitutions are acceptable.

2.06 OUTPUT CONTROL MODULE

A. Output control module provides sixteen (16) SPDT (Form C) outputs rated at 5 amperes. One (1) power status input, and (1) tamper input. Connects to intelligent controller using RS-485 data connection.

B. Provide Lenel Model #LNL-1200. No substitutions are acceptable.

2.07 EQUIPMENT ENCLOSURE - LARGE

A. Large equipment enclosure for CAAMS equipment, 36"H x 30"W x 4.5"D. 16 Gauge steel construction with top and bottom cabinet locks. Removable back plate with mounting provisions for Lenel modules, power supplies and other equipment.

B. Enclosure shall provide space for up to six (6) Lenel modules, two (2) power supplies, accessory modules and standby batteries
C. Provide Life Safety Power Model #E8M. No substitutions are acceptable.

2.08 EQUIPMENT ENCLOSURE - SMALL

A. Small equipment enclosure for CAAMS equipment, 24H x 20W x 4.5D.16 Gauge steel construction with cabinet lock. Removable back plate with mounting provisions for Lenel modules and other equipment.
B. Enclosure shall provide space for up to six (6) Lenel modules.
C. Provide Life Safety Power Model #E4M. No substitutions are acceptable.

2.09 POWER SUPPLY

A. Power supply for use in powering all CAAMS equipment including electric lock hardware. User-selectable for 12 VDC at 20 amperes, or 24 VDC at 10 amperes. Microprocessor controlled charging process provides proper charging current for the battery and the fastest charge time. Maximum output ripple of 120 Millivolt peak-to-peak. Line Regulation ± 0.1%, Load Regulation ± 2%. Provides integral processor that allows monitoring, programming and reporting of power supply through network interface.
B. Independent charging circuit with programmable charging current settings at .25 amperes, .5 amperes, 1 amperes, and 5 amperes. 80 ampere-hour battery charge capacity.
C. Provide Life Safety Power Model #FPO250. No substitutions are acceptable.

2.10 POWER DISTRIBUTION MODULE

A. Power distribution module provides eight (8) individually protected Class II power outputs rated at 2.5 amperes per output. Uses solid-state circuit breakers. Provides visual indicator for each power output.
B. Provide Life Safety Power Model #D8P. No substitutions are acceptable.

2.11 LOCK CONTROLLER MODULE

A. Lock controller module provides eight (8) relay-controlled lock outputs. Each output may be programmed for the following modes:

1. Voltage output from power supply one.
2. Voltage output from power supply two.
3. Fail-safe.
4. Fail-secure.
5. Normally open dry contact.
6. Normally closed dry contact.
7. Fire alarm interface for egress lock control.

B. Provide Life Safety Power Model #C8P. No substitutions are acceptable.

2.12 NETWORK INTERFACE MODULE

A. Four-port network communication interface allows remote power monitoring, reporting and control of up to four (4) power supplies and accessories. Connects to remote power manager software over TCP/IP network connection.

B. Provide Life Safety Power Model #NL4. No substitutions are acceptable.

2.13 BATTERIES

A. Rechargeable sealed lead-acid battery to provide back-up power to CAAMS power supplies.12 volts, 12 ampere hour. Rugged impact resistant ABS case. Valve regulated spill-proof construction. F2 quick-disconnect tabs for power connections.

B. Batteries shall be sized to provide a minimum of four hours of operation of all system components, including control equipment, card readers, request-to-exit devices, and electric lock hardware.

C. Provide Powersonic Model #PS-12120.

2.14 MULTI-TECHNOLOGY CARD READER

A. Multi-technology access card reader that features ability to simultaneously read multiple card formats including:

1. UTC ProxLiteTM and ISO ProxLite.
2. HID 125 kHz ProxCard II, ISOProx II, ProxKey II, and ProxCard and Corporate 1000 formats.
3. MIFARE ISO 14443A Card Serial Number (CSN).
4. MIFARE/DESFire CSN.
5. Vicinity ISO 15693 CSN.
6. HID iCLASS CSN.

B. Operates at 6 to 16 VDC and supports both Wiegand and F/2F compatible communications formats. Tri-color status indicator and audible sounder

C. Provide UTC Fire & Security Model #T-520SW. No substitutions are acceptable.

2.15 MULTI-TECHNOLOGY CARD READER WITH KEYPAD

A. Multi-technology access card reader with integral PIN keypad. Reader features ability to simultaneously read multiple card formats including:

1. UTC ProxLiteTM and ISO ProxLite.
2. HID 125 kHz ProxCard II, ISOProx II, ProxKey II, and ProxCard and Corporate 1000 formats.
3. MIFARE ISO 14443A Card Serial Number (CSN).
4. MIFARE/DESFire CSN.
5. Vicinity ISO 15693 CSN.
6. HID iCLASS CSN.

B. Operates at 6 to 16 VDC and supports both Wiegand and F/2F compatible communications formats. Tri-color status indicator and audible sounder. Includes integral twelve-button numeric keypad.
C. Provide UTC Fire & Security Model #T-500SW. No substitutions are acceptable.

2.16 MULTI-TECHNOLOGY CARD READER – MULLION MOUNT

A. Multi-technology access card reader that features ability to simultaneously read multiple card formats including:

1. UTC ProxLiteTM and ISO ProxLite.
2. HID 125 kHz ProxCard II, ISOProx II, ProxKey II, and ProxCard and Corporate 1000 formats.
3. MIFARE ISO 14443A Card Serial Number (CSN).
4. MIFARE/DESFire CSN.
5. Vicinity ISO 15693 CSN.
6. HID iCLASS CSN.

B. Reader shall be designed to mount on standard 1.75” and 2” wide mullions. Dimensions of reader shall not exceed 1.73” wide x 5.83” high x 1.18” deep.
C. Operates at 6 to 16 VDC and supports both Wiegand and F/2F compatible communications formats. Tri-color status indicator and audible sounder
D. Provide UTC Fire & Security Model #T-520SW. No substitutions are acceptable.

2.17 REQUEST-TO-EXIT (REX) MOTION DETECTOR

A. Passive infrared (PIR) motion detector specifically designed for use as request-to-exit (REX) detector for access control systems. Curtain type Fresnel lens with adjustable coverage pattern. Red and green indicator light. Adjustable timer. SPDT relay output contacts rated at one ampere. Operates and 12 to 28 VDC. Built-in audible sounder.
B. Provide Kantech Systems Model #T.REX-XL. No substitutions are acceptable.
C. Provide with mounting plate to enable mounting to standard single-gang electrical box. Kantech Systems Model #T.REX-PLATE.
D. REX motion detectors shall not be required at doors whose lock hardware includes a built-in request-to exit switch.

2.18 AUDIBLE SOUNDERS USED AT DOORS

A. Piezo electronic sounder mounted to single-gang stainless steel plate. 12 VDC operation.
B. Sounder shall provide audible output of not less than 85 db when measured at three feet.

2.19 EOL RESISTOR PACK

A. End-of-line (EOL) resistor pack with 1000 ohm supervisory resistor.
B. Provide George Risk Industries Model #6644. No substitutions are acceptable.

2.20 WIRE AND CABLE

A. Provide cabling between all CAAMS equipment in accordance with manufacturer's requirements. All cabling shall be shielded unless otherwise specified by manufacturer.
B. Wire and cable shall be sized to provide minimum resistance and minimum voltage drop to the devices being supplied. Voltages delivered to all devices shall be within the tolerance specified by the device manufacturer.
C. No conductor shall be smaller than #22 AWG gauge.
D. Wire to electric lock hardware shall be no smaller than #16 AWG gauge unless otherwise noted.
E. All wire and cable installed within ceiling plenums, air handling spaces, and cable trays shall be UL listed for such use.
F. Comply with equipment manufacturer's recommendations for wire and cable.
G. Comply with all applicable code requirements.

2.21 COMPOSITE CABLE

A. Plenum-rated composite cable for use between CAAMS backboard and access controlled doors. Consists of the following elements:

   1. Element 1: 22 AWG 3 Pairs Shielded.
   2. Element 2: 16 AWG 2 Conductor Shielded.
   3. Element 3: 22 AWG 6 Conductor Shielded.
   4. Element 4: 22 AWG 2 Conductor Shielded.

B. Provide Lake Cable Part #S16C4E-06RFI. No substitutions are acceptable.

2.22 WIRELESS LOCKSETS

A. Wireless locksets may be used on interior doors on a case-by-case basis as approved by the CAAMS Manager. In no case shall wireless locksets be used on building exterior doors.
B. Wireless locksets shall be self-contained lockset units that provide stand-alone access control capability at the door. Wireless locksets shall include card reader, electric lock, door position switch, and request-to-exit device. Wireless locksets shall have the following capabilities at a minimum:

   1. Self-contained processor that stores cardholder locally and provide processing of access requests at the doors.
   2. Battery-powered using standard AA batteries.
   3. Available in cylindrical lock, mortise lock, and exit device configurations.
   4. Provides wireless communications with wireless portal gateway using 2.4 GHz spread spectrum wireless signal with AES 128 bit encryption.

C. Wireless portal gateways shall serve as interface between CAAMS and wireless locksets. Wireless portal gateways shall be provided in locations as needed to reliably communicate with wireless locksets. Wireless gateway portals shall have the following capabilities at a minimum:

1. Communicates to wireless locksets using 2.4 GHz spread spectrum wireless signal with AES 128 bit encryption.
2. Capable of supporting from 1 to 64 wireless locksets.
3. Uses 802.15.4 protocol with clear channels above 802.11 to allow interoperability with Wi-Fi.
4. Connects to CAAMS VLAN using 10/100/1000 Base-T bit Ethernet.
5. Appears as Intelligent Controller to Lenel OnGuard software.

D. Approved Manufacturer/Model Numbers (verify currently approved products with CAAMS Manager prior to submitting bid):

1. Wireless Locksets, Mortise Locks: Stanley Security Solutions/Best Access 45 HQ Series. Coordinate lock function, lever and trim style, finish and handing with architectural door and hardware schedule.
2. Wireless Locksets, Cylindrical Locks: Stanley Security Solutions/Best Access 9KQ3, 9KQ4, and 9KQ5 Series. Coordinate lock function, lever and trim style, finish and handing with architectural door and hardware schedule.
3. Wireless Locksets, Exit Device Trim: Stanley Security Solutions/Best Access EXQ Series. Coordinate lock function, lever and trim style, finish and handing with architectural door and hardware schedule.
4. Wireless Portal Gateways: Stanley Security Solutions/Best Access WQX Series. Provide with enclosure and antenna type as required to meet requirements of application. Locations and quantities of wireless portal gateways to be determined by Contractor based on engineering studies that consider quantities and locations of locksets, signal propagation through building materials, and availability of suitable mounting locations.

PART 3 – EXECUTION

3.01 GENERAL

A. Provide all labor, tools, supplies, materials, and equipment required for the design, installation, configuration, programming, and testing of a complete and operational building access control system.

B. Install all equipment in accordance with manufacturer's instructions and approved shop drawings.

3.02 INTELLIGENT CONTROLLER PANEL INSTALLATION

A. Install each panel at CAAMS backboards in equipment closet locations as indicated.

B. Install each panel at a location and height to facilitate ease of service.

C. Identify the software and hardware address of each panel with a permanent metal marking label installed on the exterior of the cabinet.

D. Neatly dress and tie all wiring within panel. Do not obstruct access to terminal strips and configuration jumpers with wiring.

E. Provide terminating resistor on all unused input connections.

F. Label all inputs and outputs with a permanent marking label.
G. Ground all shielded cables in accordance with manufacturer's instructions.
H. Trim and wrap all unused shield wires to prevent shorting or inadvertent grounding.

3.03 CONNECTIONS TO CAMPUS NETWORK

A. University will provide two data outlets at each CAAMS backboard location, and will provide network cabling from outlets to the nearest network switch. Data outlets shall be assigned to the CAAMS virtual LAN (VLAN) and used for no other purpose.
B. Contractor shall provide connections between data outlets and Intelligent Controller and power supply network interface module.
C. Other types of security systems (video surveillance systems, intrusion alarm systems, etc.) shall not be connected to the CAAMS VLAN.

3.04 POWER SUPPLY INSTALLATION

A. Install all system power supplies at Intelligent Controller panel backboard locations as indicated. Do not install power supplies at other locations.
B. Provide adequate clearance around all power supplies to permit dissipation of heat.
C. Install wiring harness between batteries and power supplies.
D. Connect power fault output from each power supply to input point on Intelligent Controller.
E. Power all electric lock hardware from 24 VDC lock power supply located at equipment backboard.
F. All system accessories, such as REX motion detectors, card readers, door alarm horns, piezo-sounders and the like shall be powered from 12 VDC power supply located at equipment backboard.
G. Install label on all power supply batteries indicating the date that they were placed into service.
H. 120 VAC input connections to power supplies to be provided under other sections.

3.05 CARD READER INSTALLATION

A. Securely mount all card readers using tamper-resistant fasteners.
B. Card readers shall completely cover any electrical back box. Provide trim plates at locations where required.
C. Completely seal openings in exterior walls for outdoor mounted card readers to make weather-tight.

3.06 CONNECTION TO ELECTRIC LOCK HARDWARE

A. Provide wiring and final connection to electric strikes, electric locks, transfer hinges, electric exit devices, and other such devices furnished under other specification sections.
B. Verify operating voltage and current requirements of each piece of hardware provided. Thoroughly test all electric lock hardware for proper operation.
C. Install pilot relay to control lock hardware where current requirements of hardware exceeds relay contact rating of Intelligent Controller or where electrical isolation is required.

3.07 CONNECTION TO MAGNETIC CONTACT SWITCHES

A. Provide cabling and connection to magnetic contact switches (door position switches) furnished under other sections.
B. Install end-of-line resistor pack at each contact switch. Resistor pack shall not be installed at locations away from device.
C. Test all contact switches for proper operation.

3.08 CONNECTION TO AUTOMATIC DOOR OPENERS

A. CAAMS shall be used to sequence the operation of card reader controlled doors that are equipped with automatic door openers. Door opener actuator buttons shall be connected as inputs to a CAAMS input control module, and the door operator activation signal shall be connected to an output on a CAAMS output control module.
B. Provide cabling and connections between electric lock hardware, automatic door openers, and door actuator buttons as indicated.
C. Configure CAAMS software as needed to establish desired sequence of operation including timing.
D. Coordinate work with installer of automatic door openers.

3.09 CONNECTION TO ELEVATORS

A. Coordinate installation of access control system for elevator with elevator installer.
B. Coordinate requirements for conductors in elevator traveling cables with elevator installer. Verify that conductor quantities and types are suitable for use with card reader.
C. Provide card readers to elevator installer for installation in elevator. Provide information on how to properly install and connect reader.
D. Provide interface cabling between access control system and elevator control equipment. Route cabling in elevator machine room to locations designated by elevator installer.
E. With cooperation and assistance of elevator installer, fully test all elevator control functions. Provide assistance to elevator installer as required to troubleshoot any elevator control related problems.

3.10 DEVICE WIRING, GENERAL

A. Comply with manufacturer recommendations concerning the installation of wiring and cable. Observe cable distance limitations as outlined by manufacturers.
B. The distance of cabling used for card readers shall not exceed the Wiegand protocol distance limitation of 500’.
C. Use standard and consistent wire conductor color-coding for device wiring. Use the same colors for each function throughout the project; for example, red and black-colored wires are always used for power; green and yellow-colored wires for detection circuit, etc.
D. Install end-of-line resistor pack at detection device. Resistor pack shall not be installed at locations away from device.
E. Provide separate conduits and raceways for CAAMS cabling. Do not mix CAAMS cabling with power wiring or with the cabling of other systems that may cause electrical interference.

3.11 INSTALLATION OF REX MOTION DETECTORS

A. Install detector to provide positive detection of person approaching door to exit. Direct detector to minimize unwanted detection in halls, corridors, rooms, etc. Carefully adjust to provide trouble-free REX operation.

3.12 PROGRAMMING AND CONFIGURATION

A. Contractor shall provide initial programming and configuration of the access control system. This shall include configuration of existing host computer software as necessary to accommodate addition of this building to the campus system.
B. Programming shall include defining doors, door groups, inputs, input groups, outputs, output groups, maps, map groups, alarms, alarm groups, and other such system parameters. Input of all program data shall be by Contractor. Contractor shall consult with University CAAMS Manager to determine operating parameters.

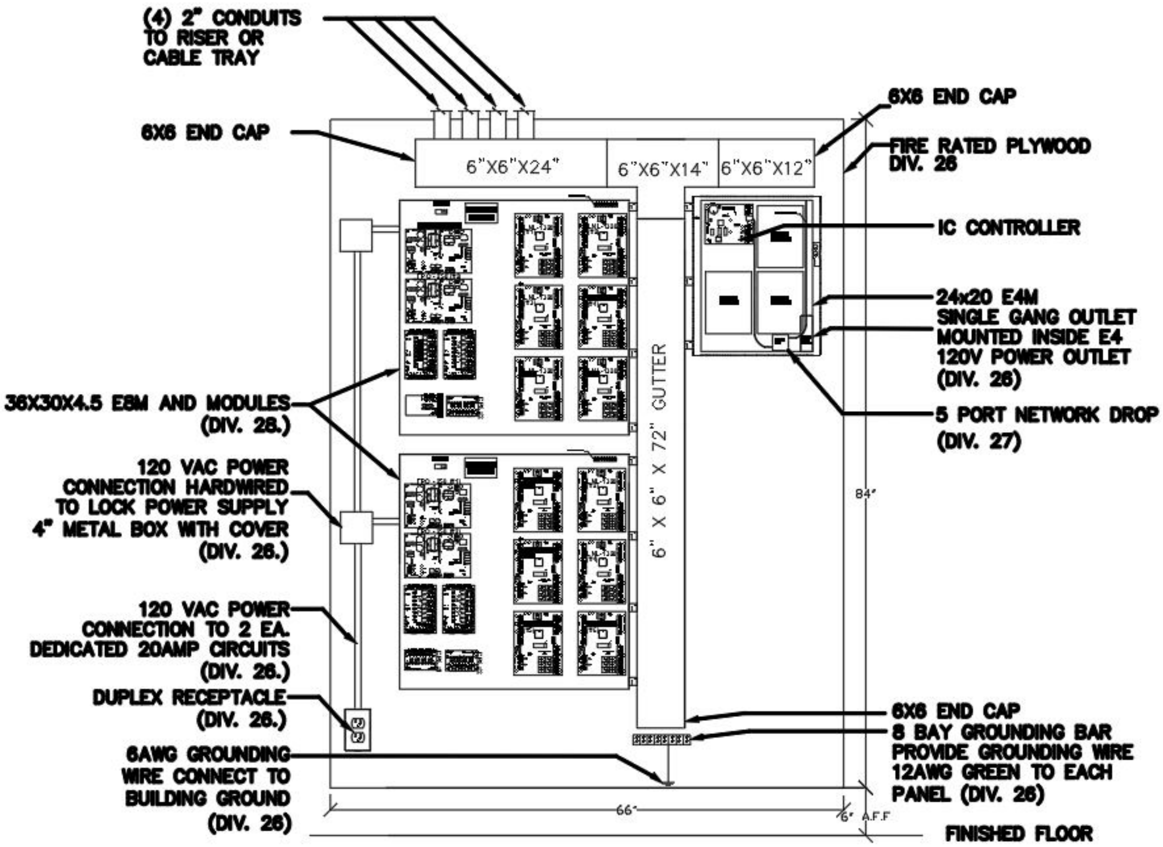


Figure 2 - Example of Typical CAAMS Backboard

Space Management

A. Guidelines for Space Management

Space is an important physical resource, and its use should be optimized to support the university's academic, research and service missions. The university is continually launching new programs and developing new research areas, and facility changes to accommodate this perpetual redevelopment are essential for the continued vitality of our institution. The university's ability to sustain itself over the long term requires strategic space planning and effective fiscal management. These guidelines are intended to identify consistent practices to support the university's programs and its strategic decision-making.

All space belongs to the university, rather than being "owned" by any college, department or individual. The provost is the final decision-maker for space allocation[6] . The common method of space management on campus is via a hierarchy of delegated control from the provost to schools, colleges or business units, which in turn may delegate management to departments or other units, where allocations are made to individuals.

The principles that guide space management at the University of Washington include these:

1. Space function and use shall be maximized through effective space management practices, while configuration and layout should maximize flexibility to meet future needs.
2. University resources shall be used efficiently and responsibly. In addition to the initial cost of new construction, consider life-cycle costs - the cost to operate, maintain and renew facilities over the life of the building - and the campus infrastructure costs to support buildings. Given the financial realities impacting our ability to build new space, it is critical that we make the best use of the space that we have.
3. Renovation and new construction shall be treated as opportunities to create better performance, greater functionality, and increased flexibility.

Development of These Guidelines

This document reflects the State of Washington's Facilities Evaluation and Planning Guide (FEPG; Inter-Institutional Committee of Space Officers, 1994), which outlines baseline space use expectations for the University of Washington. It also incorporates best practice and benchmarks from other universities and the private sector.

[6] Executive Order No. 4, "The Provost," http://www.washington.edu/admin/rules/policies/PO/EO4.html

Definition of Measurement Terms

The sum of all area on all floors of a building, measuring from the outside of the exterior walls, is identified as gross square feet (GSF). The space that can be assigned to occupants for a specific use is identified as assignable square feet (ASF). Spaces essential to building operation but not assignable to people or programs, such as public corridors, electrical and mechanical rooms, restrooms and custodial rooms, are called non-assignable spaces. These are included in counts of gross square feet but not in counts of assignable square feet.

UW ROOM SIZE GUIDELINES

The intent of these guidelines is to maximize assigned space. They are designed to be used for new construction and renovation, but may also help users evaluate current space use. Current best practice is to allocate space based on functional needs rather than job title. Where individual space sizes are smaller than in past practice, it reflects a desire to regain some space formerly held for private use and re-purpose it for other, common program needs. The total space devoted to staff and faculty is not reduced, but redistributed to include a range of space types suitable for private work or collaboration.

OFFICE SPACES

Private office space: 100 - 120 asf. The range provided is intended to provide some flexibility in the allocation for faculty and staff who require confidentiality within an enclosed space.

Departments are encouraged to engage in serious conversation about the degree of privacy needed by staff members, and explore new opportunities to use shared or open offices. For example, a staff member who engages in confidential conversation for 50% or more of the work week typically requires a private office, while staff whose work entails less frequent confidential conversation may not. This represents a culture shift for some units. The university's goal is to be as forward-looking and flexible in space use as possible, and greater use of open offices is consistent with that goal.

Open work space: Station size approx. 50 asf. Footprint might be 7'x7', 6'x8', or similar. This size station may be used for staff and postdoctoral fellows. Open work spaces should be accompanied by common areas for collaboration and a variety of rooms for noisier group work or private conversation/phone calls and heads-down work.

Our goal is not to have significantly less overall footprint, but to recapture underutilized space from private offices or larger cubes and convert it into a shared resource that facilitates collaboration.

For example, a recent project created 6' x 7' professional stations at the UW Tower, as shown in the photo. The table in the photo is a sit/stand desk. Computer monitors will be mounted on moveable arms and won't take up desk space.

Student Stations: 24 asf station. Figure 4' x 6', providing a 4' wide work surface.

Adding circulation for an open student office, you might estimate a room's capacity at 50 asf/station. A 120 asf office should be able to house three graduate student stations (40 asf/station).

Article 35 of the UAW Academic Student Employees Contract, section 1, states that contract-covered student employees be provided "reasonable access to facilities…required for the position."

Conference Rooms: 20 asf/seat, with a variety of sizes based on need.

Multiple Office Assignments: People who need to work in more than one building would most appropriately have only one dedicated space, making use of hoteling space at their alternate work locations.

CLASSROOM/LEARNING SPACES – in development

RESEARCH LAB – in development

UTILIZATION TARGETS

CLASSROOMS

1. Use of classroom hours, based on a 50-hour daytime teaching week: average 70% of hours assigned for scheduled classes.

2. Use of classroom seats: average 70% of seats filled when a classroom is in use.

OFFICES

1. Total office and office support space: average of 140 asf per FTE

Plants – Standard Specifications

A. Plants

PART 1 – GENERAL

1.01 SUMMARY

A. Section Includes:

1. Furnish all labor, material, tools, machinery and equipment necessary to install a complete and finished landscape installation as indicated on the drawings and specified herein.
2. Work includes, but is not limited to:

   a. Exterior Planting

      i. Plants
      ii. Planting Soils
      iii. Tree Stabilization
      iv. Mulch
      v. Fertilizer
      vi. Finish Grading

1.02 DEFINITIONS

A. Retain definition(s) remaining after this Section has been edited.
B. Backfill: The earth used to replace or the act of replacing earth in an excavation.
C. Balled and Burlapped Stock: Plants dug with firm, natural balls of earth in which they were grown, with ball size not less than diameter and depth recommended by ANSI Z60.1 for type and size of plant required; wrapped with burlap, tied, rigidly supported, and drum laced with twine with the root flare visible at the surface of the ball as recommended by ANSI Z60.1.
D. Balled and Potted Stock: Plants dug with firm, natural balls of earth in which they are grown and placed, unbroken, in a container. Ball size is not less than diameter and depth recommended by ANSI Z60.1 for type and size of plant required.
E. Bare-Root Stock: Plants with a well-branched, fibrous-root system developed by transplanting or root pruning, with soil or growing medium removed, and with not less than minimum root spread according to ANSI Z60.1 for type and size of plant required.
F. Container-Grown Stock: Healthy, vigorous, well-rooted plants grown in a container, with a well-established root system reaching sides of container and maintaining a firm ball when removed from container. Container shall be rigid enough to hold ball shape and protect root mass during shipping and be sized according to ANSI Z60.1 for type and size of plant required.

G. Duff Layer: The surface layer of native topsoil that is composed of mostly decayed leaves, twigs, and detritus.
H. Fabric Bag-Grown Stock: Healthy, vigorous, well-rooted plants established and grown in-ground in a porous fabric bag with well-established root system reaching sides of fabric bag. Fabric bag size is not less than diameter, depth, and volume required by ANSI Z60.1 for type and size of plant.
I. Finish Grade: Elevation of finished surface, which is top of mulch for planting areas, top of planting soil for hydroseeding and seeding areas, and top of sod for sod areas.
J. Manufactured Topsoil: Soil produced off-site by homogeneously blending mineral soils or sand with stabilized organic soil amendments to produce planting soil.
K. Pesticide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. This includes insecticides, miticides, herbicides, fungicides, rodenticides, and molluscicides. It also includes substances or mixtures intended for use as a plant regulator, defoliant, or desiccant.
L. Pests: Living organisms that occur where they are not desired, or that cause damage to plants, animals, or people. These include insects, mites, grubs, mollusks (snails and slugs), rodents (gophers, moles, and mice), unwanted plants (weeds), fungi, bacteria, and viruses.
M. Planting Area: Areas to be planted.
N. Planting Soil: Standardized topsoil; existing, native surface topsoil; existing, in-place surface soil; or manufactured topsoil that is modified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth.
O. Plant; Plants; Plant Material: These terms refer to vegetation in general, including trees, shrubs, vines, ground covers, ornamental grasses, bulbs, corms, tubers, or herbaceous vegetation.
P. Root Flare: Also called "trunk flare." The area at the base of the plant's stem or trunk where the stem or trunk broadens to form roots; the area of transition between the root system and the stem or trunk.
Q. Stem Girdling Roots: Roots that encircle the stems (trunks) of trees below the soil surface.
R. Subgrade: Surface or elevation of subsoil remaining after excavation is complete, or the top surface of a fill or backfill before planting soil is placed.
S. Subsoil: All soil beneath the topsoil layer of the soil profile, and typified by the lack of organic matter and soil organisms.
T. Surface Soil: Soil that is present at the top layer of the existing soil profile at the Project site. In undisturbed areas, the surface soil is typically topsoil; but in disturbed areas such as urban environments, the surface soil can be subsoil.

1.03 SUBMITTALS

A. Submit samples in accordance with Section 013300 and the following:

1. Submit one gallon sample of each type of mulch. Provide product name, source, and supplier with sample.
2. Submit product cut sheets for tree rootball anchor assembly.
3. Maintenance Instructions:

a. Recommended procedures to be established by Contractor for maintenance of landscape and plantings for one (1) calendar year following substantial completion and final acceptance including completion or negotiated deferral of all landscape, irrigation and site punchlist items. Submit before start of required maintenance periods.
b. Maintenance instructions submittal shall include all notifications

4. Warranty: Sample of special warranty.

B. Schedules:

1. Submit a planting schedule prior to beginning work indicating dates, location, and types of work expected to be performed, during normal seasons for such work in areas of the site.
2. Correlate with specified maintenance periods to provide maintenance from date of substantial completion.
3. Once accepted, revise dates only as approved in writing, after documentation of reasons for revision.

C. Certifications:

1. Submit certificates of inspection of plant materials as required by governmental authorities having jurisdiction.
2. Submit proof of deposit, purchase or other means of securing all plant material for this project including location, quantity, genus, species and broker or contact person at individual nurseries.
3. File inspection certificates which are required by law to accompany each shipment of plant materials from out of state with Owner. Five (5) days prior to arrival at project site and before planting, notify Architect for review of plant material. Replace any plants rejected by Architect as not conforming to specified requirements with healthy plant of type specified.

1.04 QUALITY ASSURANCE

A. Qualifications: Subcontract the landscaping work to a single firm specializing in landscape work with a minimum 10 years of continuous engagement in landscape construction and a minimum of five projects that are similar in scale and complexity.
B. Nursery Qualifications:

1. Experience: Landscape nursery to provide a detailed description of total area available for contract growing and history of contract growing for other projects.
2. Location: All plant material shall be grown at a single site within 50 miles of Seattle to facilitate regular inspections by the Architect.
3. Available nursery space: Total exterior nursery space should correspond appropriately to total planting areas.

C. Trees, Shrubs, and Plant Production:

1. Containers: All plant material shall be grown with a root pruning system approved by the Architect, such as fabric grow bags or air-pruning containers. Throughout production for given plant sizes, container and fabric bag sizes shall correspond to specifications outlined in the American Standard for Nursery Stock, except where approved by the Architect.
2. Non-standard containers: To adequately address constrained soil depths in the mid-block plaza, some trees may require non-standard containers, to be agreed upon after discussion between the Architect and the Nursery (e.g. grow bags that are wider and shallower than standard).
3. Growing media: Specifications for all growing media shall be submitted to the Architect for approval.
4. Fertilizers: The use of fertilizers shall be limited, meeting only the basic requirements for healthy plant growth. All fertilizer products shall be submitted to the Architect for approval.
5. Mycorrhizae: All growing media shall be inoculated with appropriate mycorrhizae, as approved by Architect.
6. Pruning: Pruning of woody plant material shall be performed according to ANSI A300 standards. For all trees, the Architect will advise on pruning to achieve aesthetic and functional goals.
7. Tree specification:

   a. There shall be no roots greater than 1/10 diameter of the trunk circling more than
   b. one-third the way around in the top half of the root ball. Roots larger than this may be cut provided they are smaller than one-third the trunk diameter. There shall be no kinked roots greater than 1/5 the trunk diameter. Roots larger than this can be cut provided they are less than one-third the trunk diameter.
   c. Trees should be rooted in to the rootball so that soil or media remains intact and trunk and rootball move as one when lifted, but not root bound. The trunk should bend when gently pushed and should not be loose so it pivots at or below soil line.
   d. The point where the top-most root in the rootball emerges from the trunk shall be no deeper than one inch of the soil surface.
   e. The relationship between caliper, height and rootball size shall meet the ANSI Z60.1 standard or the Florida grades and standards for nursery stock.
   f. There should be one dominant leader to the top of the tree with the largest branches spaced at least 6 inches apart.
   g. The tree canopy should be mostly symmetrical and free of large voids. Clear trunk should be no more than 40% of the tree height unless otherwise specified by the Architect.
   h. Branches should be less than 2/3 the trunk diameter.
   i. Trees greater than 1.5 inches caliper should be able to stand erect without a supporting stake.
   j. Open trunk and branch wounds shall be less than 10% of the circumference at the wound and no more than 1 inch tall. Properly made pruning cuts are not

considered open trunk wounds. There should be no conks or bleeding, and there should be no signs of insects or disease on more than 5% of the tree.

8. Planting depth: Throughout production, the root flare of wood plant material shall remain visible at or above soil level.
9. Growing durations: Production schedules will vary depending on plant growth rates and propagation methods. Assume that trees for streetscape and plaza areas should be brought in at the earliest possible date to meet the minimum specified size and quality upon installation. Submit production schedule for all plant material, demonstrating ability to provide specified sizes and quantities.
10. Provide quantity, size, genus, species and variety shown and specified, complying with recommendations and requirements of ANSI Z90.1., American Standard for Nursery Stock.
11. Trees and shrubs of larger size than specified may be used if acceptable to Architect and if sizes of roots or balls are increased proportionately.
12. Plants to be in vigorous health, free of all pests, disease, fungus, disfiguring knots, sun scalds, damaged foliage, abrasions of the bark, broken tops, torn roots, and other objectionable features. Plants cut back from larger sizes to meet specified size will not be accepted. Upon arrival to site, all plant material must show no sign of windburn or wilt due to shipping. All plants to be nursery-grown stock unless otherwise approved by Architect. Plants are to be of specimen quality as described by the "American Nursery Stock Standards."
13. Where formal arrangements or consecutive order of trees or shrubs are shown, select stock for uniform height and spread.
14. Reference Standards: “Hortus Third”; Cornell University, (current edition) and “Sunset Western Garden Book”, (current edition) for plant nomenclature.

D. Analysis and Standards: Package standard products with manufacturers or applicable industry standard certified analysis.
E. Inspections by Architect: All plant material shall be available for regular inspection by the Architect, who will evaluate whether plant health and quality expectations are being met. Should the Architect determine that the plants are not meeting expectations, adjustments will be made accordingly to the satisfaction of the Architect.
F. It is suggested that an additional 15% of plant quantities be produced to allow for replacements of failed stock.

1.05 DELIVERY, STORAGE, & HANDLING

A. Deliver packaged materials in manufacturer's unopened containers, fully identified by name, brand, type, weight, and analysis.
B. Deliver and store materials to prevent damage or intrusion of foreign matter.
C. Deliver trees, shrubs and groundcovers after preparations for planting have been completed and the irrigation system is operational. Then plant immediately.

1. Protect trunks and branches from damage.
2. Protect root systems from drying out.

3. Label one of each tree and shrub variety with securely attached waterproof tag bearing legible designation, botanical name, and supplier's name.
4. Do not prune prior to delivery unless otherwise approved by Architect.
5. Provide shade for plant material if planting is delayed more than 6 hours after delivery to site. Water as required to keep rootball moist.

D. Do not remove container-grown stock from containers until planting time.

E. Plants that cannot be planted within one day after arrival on site shall be stored in accordance with sound horticultural practice, protecting plant materials at all times from extreme weather conditions and keeping them moist.

1. Place bare root plants in trenches covering roots with moist earth or other suitable material. All broken root material supplied in bundles shall have the bundle broken and be placed in trenches separately.
2. Protect root ball of balled and burlapped plants with moist earth, sawdust or other acceptable material.
3. Protect plant materials at all times from extreme weather conditions and keep moist. All plants that are to be stored longer than one month shall be planted in nursery rows and maintained by contractor at contractor’s expense.

1.06 SITE CONDITIONS

A. Field Measurements: Verify actual grade elevations, service and utility locations, irrigation system components, and dimensions of plantings and construction contiguous with new plantings by field measurements before proceeding with planting work.

B. Weather Limitations: Proceed with planting only when existing and forecasted weather conditions permit planting to be performed when beneficial and optimum results may be obtained. Apply products during favorable weather conditions according to manufacturer’s written instructions and warranty requirements.

C. Execute all work in an orderly and careful manner with due consideration for surrounding areas, plantings, or structures which are to remain.

1. Protect adjacent property and improvements from work damage.
2. Repair any damage until acceptable to Architect.

D. Protect pavement, furnishings and other improvements from damage, soiling, or discoloration.

E. Sub-grade Condition: Compaction of backfill or sub-grade areas that are to be planted shall not exceed 80% compaction.

F. Examine sub grades, finish grades, verify elevations, observe conditions under which work is to be performed and notify Architect of unsatisfactory conditions.

1. Maintain grade-set stakes until Architect and Contractor mutually agree upon removal.
2. Proceed with work only after unsatisfactory conditions have been corrected.

G. Excavation: When conditions detrimental to plant growth are encountered, such as adverse drainage conditions and or contaminated soil, notify Architect before proceeding.

H. Proceed with and complete the landscape work as rapidly as portions of the site become available, working within the seasonal limitations for each type of planting work required.
I. Utilities: Determine location of utilities and perform work in manner which will avoid possible damage; hand excavate as required.
J. Environmental Requirements:
   1. Plant or install materials during normal planting seasons for each type of planting required.
   2. Planting shall not be permitted during the following conditions:
      a. Cold weather: less than 32 degrees F.
      b. Hot weather: greater than 90 degrees F.
      c. Wet weather: saturated soil.
      d. Windy weather: wind velocity greater than 30 m.p.h.
K. Prepare soil only when topsoil is not saturated, muddy or frozen.

1.07 SEQUENCING/SCHEDULING

A. Provide the following notices to the Architect and Owner:
   1. In advance of plant material delivery so that plants may be inspected upon site delivery: 15 days.
   2. Before Owner is to assume maintenance responsibility: 15 days.
   3. In advance of final surface preparation prior to planting operations: 10 days.
   4. Before time requested for inspection for Substantial Completion: 15 days
   5. Architect may choose to waive or shorten the required lead time for project reviews, at their discretion.

1.08 WARRANTY

A. The warranty for plant materials will extend one year from the date of Final Completion for all work under this contract, except for trees greater than 3” caliper which shall have a warranty of 2-years.
   1. For replaced plant material provide extended warranty for 1-year time of replacement, or from end of standard warranty, whichever is longer.
B. Remove and replace trees, shrubs, and groundcover that die immediately, show unsatisfactory growth, or are in unhealthy condition, except for defects resulting from neglect, damage, or abuse by owner.
C. Materials not meeting quality, condition, size, or other specification requirements will be rejected and immediately removed from the site.
D. At the completion of the warranty period, the owner will inspect the site to determine the condition of materials provided under this contract.
E. Another inspection will be conducted at the end of the extended warranty period, if any, to determine acceptance or rejection.

1.09 MAINTENANCE SERVICE

1. Initial Maintenance Service for Trees, Shrubs, Groundcovers and other plants and planting elements: Provide maintenance by skilled employees of landscape Installer. Maintain as required in Part 3. Begin maintenance immediately after plants are installed and continue until plantings are acceptably healthy and well established but for not less than maintenance the period below.
2. Maintenance Period: 1 year from date of Final Completion and Acceptance.

PART 2 – PRODUCTS

2.01 MATERIALS

A. Water: Suitable for irrigation, free from ingredients harmful to plant life.
B. Plants:
   1. Provide plants free of disease, injury and insect infestation, and full foliaged when in leaf.
   2. Container stock: Grown in container at least 6 months without root bind.
   3. Provide trees and shrubs in approved root-control container, unless otherwise indicated.
C. Mulch:
   1. All mulch, except at Seattle Parks and Recreation property, shall be medium-fine bark mulch, unless otherwise indicated. Submit sample for Architect's approval.
   2. Provide Arborist Woodchip mulch at Seattle Parks and Recreation property only.
   3. Install UW provided Arborist Woodchip mulch at UW property (confirm availability), or commercially available Arborist Woodchip mulch if approved by owner and UW representative.
   4. At curbs, hold mulch at 2" below top of back of curb. At hardscape edges, provide mulch flush to ½" below finish grade of hardscape. Provide 3" soil taper across 15" horizontally, to maintain full depth of mulch profile.
D. Fertilizer: Controlled release commercial fertilizer, tablets or granular form. Complete fertilizer of neutral character, with some elements derived from organic sources and containing the following percentages of available plant nutrients:
   1. For trees and shrubs, provide fertilizer with not less than 10% total nitrogen and 10% soluble potash, unless otherwise directed by the Architect.
   2. Application of all chemical additives shall follow the Salmon-Safe Urban Standards. No chemicals on the Salmon-Safe Urban High Risk Pesticide List shall be used on this project.
E. Tree Rootball Anchor System: See Details.
   1. Basis of Design: RF2 Special I Rooftop Fixing System – Plati-Mat
F. Anti-Desiccant: Emulsion type, film-forming agent design to permit transpiration but retard excessive loss of moisture from plants, manufactured by "Wilt-Pruf".

PART 3 – EXECUTION

3.01 EXAMINATION

A. Examine for site conditions that will adversely affect execution, permanence, quality of work, and survival of plants.
B. Begin work required under this section after conditions are satisfactory; start of work denotes acceptance by Contractor and he/she assumes responsibility for final results.
C. Verify that subgrades and slopes of planting areas ensure positive drainage, and that they are acceptable to Architect prior to commencing work of this Section.
D. Install plantings only after fine grading soil testing, soil preparation, and amendments have been installed.
E. Install plantings only in areas where the irrigation system is installed and fully operational.
F. Proceed with and complete the planting work as rapidly as portions of the site become available, working within the seasonal limitation for each kind of planting work required.
G. Plant trees and shrubs after final grades are established.

3.02 PREPARATION

A. Protection: Protect all adjacent property and site improvements from work damage, including staining, soiling, or discoloring, and replace portions damaged through this operation.
B. Surface Preparation:

1. Ensure clear and grub within disturbance limits has removed all vegetation, including weeds, that has been designated for removal. If additional clearing and grubbing, weed removal, or other cleanup is required, perform required work before proceeding with planting preparation.
2. Locate, and securely mark or flag irrigation sprinkler heads, area drains, catch basins, cleanouts, manholes, valve boxes, and other site improvements not extending more than 6 inches above finish grade.
3. Grading:

    a. Limit fine grading to areas ready for planting.
    b. Bring shrub and groundcover planting areas to relatively smooth, even grades, and slopes by dragging, hand raking, and other appropriate methods. Water thoroughly to assure settlement.
    c. Establish vertical curves or rounding at abrupt changes in slope to provide a smooth and gradual grade transition.

4. Lay out individual tree and shrub locations and areas for multiple planting. Stake or flag tree locations, outline shrub areas and secure Architect's acceptance before start of planting work. Make minor adjustments as may be required.

a. Architect will approve staking, layout of trees and shrubs, and approve all other site plant layout before plant installation. Contractor assumes risk of final plant locations for planting prior to layout and staking approval by Architect.
b. Make location and facing adjustments as requested by Architect.

5. Remove gravel, sand, debris, and other deleterious materials from planting areas. Remove existing soil as necessary to place planting soil mixes to the depths specified.

C. Finish Grade of Planting Areas:

1. Planting Beds: Refer to plans for finish grade at planting beds.
2. Planting Beds at R.O.W: Fill planters and shrub beds to meet required grades. Finish grade including mulch to be no more than 1/2" below adjacent paved walks.

3.03 INSTALLATION - PLANT MATERIALS

A. Planting Trees and Shrubs:

1. Oversight:

a. Project arborist shall be on-site on planting day to execute any needed pruning prior to planting or warranty plant replacements. Best practice calls to limit structural pruning until after the 1st year, however, double leaders, dead/crossing branches or branches that will be in conflict (such as roads or pedestrians) should be addressed at planting.

2. Placing:

a. Set plant root crowns 2 inches above soil surface on 6 inches of compacted prepared topsoil or compacted subgrade (scarified); deep planting not permitted. Planting depth shall allow for mulch layer and settling to position of nursery soil level.
b. Set plants plumb and faced for best appearance.
c. Remove any burlap, cords and fasteners from rootball tops and sides. Remove rootball containers with nursery industry can cutter, cut cans on two sides.
d. Cleanly cut off broken and frayed roots, as well as roots circling more than 1/3 of rootball.
e. Protect plans from hot sun and wind; remove protection if plants show evidence of recovery from transplanting shock.

3. Backfilling:

a. Carefully tamp soil under and around rootballs; eliminate voids and air pockets.
b. Water thoroughly before placing remainder of backfill.
c. Complete backfilling firming to surface grade as required.
d. Thoroughly water each plant and entire bed immediately after planting.
e. Stake or guy trees immediately after planting as specified or shown on drawings.

3.04 INSTALLATION – MISCELLANEOUS

A. Tree Staking: As shown on drawings.
B. Metal Edging:

1. Install after concrete paving, concrete unit paving, and concrete site walls are installed.
2. Prior to installation layout all steel edging by paint or string line for review and approval.
3. All steel edging to be installed plumb, true and in straight lines as shown on plans.
4. Steel edging interfaces with planter corners, and adjacent edging shall be flush and aligned.
5. Top of steel to be level without variation.
6. Steel edging at unit paving shall not protrude above paver surface.

C. Mulching: Provide three-inch depth over entire plant bed and planter areas, within two days after planting, unless otherwise indicated.

D. Anti-desiccant:

1. Use anti-desiccant spray at nursery on deciduous trees or shrubs that are moved in full-leaf before moving and again 2 weeks after planting.
2. Apply anti-desiccant using power spray to provide an adequate film over trunks, branches, stems, twigs and foliage.
3. Application of all chemical additives shall follow the Salmon-Safe Urban Standards. No chemicals on the Salmon-Safe Urban High Risk Pesticide List shall be used on this project.

3.05 ADJUSTING

A. Pruning: Prune, thin out and shape trees and shrubs in accordance with standard horticultural practice established by the International Society or Arborists. Do no pruning prior to approval by Architect.

1. Prune trees to retain required height and spread, and at no time more than 1/5 of the plant.
2. Unless otherwise directed by Architect, do not cut tree leaders, and remove only injured, broken or dead branches from trees.
3. Remove and replace excessively pruned or malformed stock resulting from improper pruning.
4. Prune without distorting basic character form of all plants and only to the extent necessary for each plant.

B. Adjust final locations of plants and/or irrigation system to maintain proper system operation from time of planting until final acceptance.

3.06 PLANT MAINTENANCE - GENERAL

A. Maintain plantings by pruning, cultivation, watering, weeding, fertilizing, mulching, restoring planting saucers, adjusting and repairing and removing tree-stabilization devices, resetting to proper grades or vertical position, and performing other operations as required to establish healthy, viable plantings. Spray or treat as required to keep trees and shrubs free of insects and disease.

B. Fill in as necessary soil subsidence that may occur because of settling or other processes. Replace mulch material damaged or lost in areas of subsidence.

C. Apply treatments as required to keep plant materials, planted areas, and soils free of pests and pathogens or disease. Use integrated pest management practices whenever possible to minimize the use of pesticides and reduce hazards. Treatments include physical controls such as hosing off foliage, mechanical controls such as traps, and biological control agents.

D. Application of all chemical additives shall follow the University of Washington Integrated Pest Management Plan for Outdoor Landscapes Guidelines for Contractors: 2019 publication including, Salmon-Safe Urban Standards. No chemicals on the Salmon-Safe Urban High Risk Pesticide List shall be used on this project.

3.07 LANDSCAPE MAINTENANCE

A. For the duration of the Maintenance Period, the Contractor shall maintain planting areas installed by the [Project] on University of Washington Property, per the requirements of the general 32 93 00 specifications, and as follows:

1. General

    a. This framework identifies the methodology and processes for The Landscape Contractor ("The Contractor") to provide Maintenance tasks described below, including but not limited to, watering, weed removal, mulching, litter removal, sweeping, blowing, fall/winter leaf removal, and irrigation maintenance. The Contractor, will maintain this property to assure the highest quality, promoting health of turf and plant material while ensuring a neat and clean appearance. Maintenance visits must be performed at least twice-monthly but tasks and frequency (i.e. weekly weeding as needed to maintain a weed-free site) may vary based on season.

2. Submittals

    a. Schedule: Contractor to provide a spreadsheet showing the timing, frequency and an overview of maintenance tasks to be performed throughout the year. The spreadsheet shall include the number of workers assigned to each task, estimated time to complete each task.

    b. Team QA/QC Meetings: Team QA/QC meetings are intended to provide mutual inspection of the work, documentation and a feedback loop with the contractor, consulting landscape architect, and UW on a bi-monthly basis for the first 3-months with the option to change to monthly meetings thereafter. Also, monthly meetings may suffice in the non-growing season months from November thru February. Such meetings may be combined with the following required meetings and documentation including pre-work check-ins with the consulting landscape architect and UW to confirm proposed tasks, post-work site observation reports submitted to the UW by the consulting landscape architect to confirm satisfactory condition of planting areas, and follow-up visits and check-ins with UW and the consulting landscape architect as required to meet the requirements outlined herein. Provide schedule to Owner at least four weeks prior to Substantial Completion for review, revision, and approval by owner, consulting landscape architect, and UW. Service will be rendered as quantified but is subject to weather conditions and may change at the discretion the contractor and without notice. Additional documentation may include plant replacement tracking in a format to be reviewed and approved by UW as part of the maintenance proposal.

3. Contractor Personnel

    a. The contractor will have an experienced supervisor responsible for the site. This supervisor will have a minimum of three (3) years' experience in landscape services.
    b. The contractor will have only properly trained personnel on site to perform all functions. They will be trained in proper horticultural and mechanical procedures to ensure that all operations are performed safely and effectively.
    c. All contractor personnel will be required to wear a clean company uniform. The supervisory personnel's uniform will be easily distinguished from other personnel. All contractor personnel will be familiar with management regulations and will conduct themselves in a safe, courteous and professional manner while on site. The supervisor will hold weekly safety meetings.
    d. Contractor to provide qualifications for each.

4. Scope of Work

    a. The contractor will provide all necessary labor, material, equipment, and fully-trained supervisory personnel to properly maintain all developed land areas within the contract limits, including lawns, shrubs, groundcover, landscape trees, vines, perennials and flowers.

5. Mulching

    a. Replenish mulch throughout entire site to maintain consistent depth per 2.1 C 4.
    b. The 3" mulch profile shall only include intact mulch and not material that has decomposed into the soil profile.
    c. Any disruptions to the mulch from work, nature, or other factors after initial mulching shall be corrected, including the protection of existing mulch to avoid contamination with soil and other debris, and the removal and replacement of any contaminated mulch with new mulch.

6. Weed Control

    a. Maintain a weed-free condition within the planting areas. Preferred weeding should be accomplished by manual means over chemical means.
    b. Site inspections, weather depending, will be carried out year-round. Weeding shall occur at least twice-monthly and at times may require weekly visits.
    c. Weeds are to be removed from the beds in compliance with the University of Washington Integrated Pest Management Plan (UW IPMP) for Outdoor Landscapes, 2019, and Salmon Safe practices. UW Grounds IPM Coordinator to communicate program requirements.
    d. Contractor shall keep the site weed free by hand removing the whole weed including roots, within 1 week of germination, prior to going to seed.

e. Upon written approval from UW, a selective, pre-emergent weed control labeled for broadleaf and grassy weeds in ornamental beds may be applied two (2) times per year prior to seed germination at the appropriate label rate necessary, to provide weed control.
f. Upon written approval from UW, a non-selective, post-emergent weed control labeled for broadleaf and grassy weeds in ornamental beds will be applied as necessary to provide weed control.
g. Herbicides shall only be applied by a licensed applicator and in strict accordance with manufacturer's direction.

7. Shrub Management:

a. This specification will cover all items of shrub management.

i. Pruning:

(a) Shrubs should not be pruned and should maintain their natural form, except as follows: Selective pruning will include the removal of dead wood, diseased wood, wood that is infested with insects, weak wood that is not productive of bloom, excess suckers-shoots, and irregular growth.
(b) Ornamental shrubs, excluding formal hedges, will be selectively pruned. DO NOT SHEAR SHRUBS. If no direction is given Contractor will perform pruning in keeping the most uniform, natural appearance and consistency of the overall site area.

ii. Fertilization:

(a) The fertilization program for ornamental trees, shrubs and ornamental beds will include one application per season.
(b) Fertilizer will be distributed by hand or hand held broadcast spreader around the drip-line of the plant.
(c) Fertilizer will be a professional grade, balanced, slow release ornamental fertilizer.
(d) Do not fertilize unless there is a deficiency demonstrated through soil nutrient testing.

iii. Shrub and Groundcover Disease and Insect Control:

(a) Quality Control personnel trained in the recognition, diagnosis and treatment of plant damaging diseases and insects will monitor site conditions. The Customer will be notified immediately of an outbreak. Notification will include recommended treatment and potential costs. Treatment will not be performed without prior authorization. Additional work to be completed and billed separately from maintenance contract.
(b) Herbicides and fungicides will be applied by a State of Washington "certified" pesticide applicator. Application will be as often as necessary to prevent insect and disease damage to shrubs. Rates and timing will follow manufacture's recommendations.

(c) The UW IPMP will be followed at all times. The pest management program will introduce the least amount of chemical into the landscape as is necessary to achieve accepted levels of control of pest populations.

8. Tree Management

   a. This section covers landscape tree management. Landscape trees are defined as trees with a caliper of 8" or less when measured 24" from ground level. The contractor will be responsible for normal maintenance up to 12' as specified below. Landscape and ornamental tree pruning is limited to work that can be reached from the ground with hand pruners, pole saws, or pole clips.
   b. Pruning:

      i. Landscape trees will be pruned to remove over extended, dead, dangerous, or broken branches
      ii. Other crossed or otherwise unsightly branches shall only be removed upon direction from a UW representative.
      iii. Ornamental trees will be pruned to remove dead or damaged branches.
      iv. Other pruning to develop the natural form of the plant shall only be performed upon direction from a UW representative.
      v. Sucker growth from the base at soil level or below will be removed.
      vi. Landscape trees will be pruned throughout the season to remove all dead, damaged and low-hanging branches.

   c. Insect and Disease Control

      i. The UW IPMP will be followed at all times. Quality Control personnel trained in the recognition, diagnosis and treatment of plant damaging diseases and insects will monitor site conditions. The Customer will be notified immediately of an outbreak. Notification will include recommended treatment and potential costs. Treatment will not be performed without prior authorization. Additional work to be completed and billed separately from maintenance contract.

9. Perennial Care

   a. All deciduous perennials, grasses, etc., are to be cut back by March as to allow new growth to develop freely.

10. Disposal

   a. Provisions may be made for the on-site disposal of leaves and organic waste with client agreement.

11. Other Trash

   a. The contractor will remove all litter and debris from common area turf, curb lines, ornamental beds and tree rings each visit. The contractor is responsible for disposal.

12. Plant Material Replacement

a. For plant mortality replacement, establish process for identifying, tracking and replacing plant materials and submit plan to UW for approval at least (4) weeks prior to substantial completion.

   i. Unless directed otherwise by UW, submit inventory of plant mortality on March 1 and on September 1 of each warranty year, along with proposed replacement stock, nursery source, and timing, for review and approval by UW.
   ii. All planting replacement must be complete between March 1 and May 1, and between September 1 and November 1.
   iii. Provide post-replacement report to UW on replaced plants and track plant replacement throughout the warranty period including quantity, species and location. Provide this document to the UW at end of warranty period.
   iv. Additional plant replacement shall be performed during winter and summer months if directed by UW.

b. For tree replacements, also refer to 3.3.A.1.

13. Irrigation

   a. In general, established plant materials need approximately ½ inch to 1 inch of water per week, including natural precipitation. Set the irrigation system to provide this amount. Monitor the site to ensure that the ground stays moist, but is not saturated. Provide sufficient available moisture at deepest root zone.
   b. Established landscapes in our region typically require irrigation from mid-July through the end of September. Seasonally adjust the automatic irrigation system to account for evaporation during the hotter months or during times of extreme heat or drought. More frequent early spring and late fall irrigation may be needed to establish new plantings.
   c. In the winter months, continually monitor “rain shadows” where building overhangs and structures obstruct natural rainfall from reaching landscape beds. If soil moisture levels drop in these areas, occasional hand watering may be required.
   d. Provide and fill water bags weekly or as needed at each tree during the growing season through the contractor maintenance period.

14. Irrigation System Maintenance and Management

   a. Contractor shall manage irrigation controller and irrigation system with UW having “read only” privileges.
   b. Contractor to provide, set, manage and monitor irrigation schedules and programs seasonal adjustments based on weather, plant type, plant water requirements, microclimate variables such as exposure, radiant and reflective heat, density, slope, and soil type.
   c. Contractor shall use a soil moisture probe to evaluate soil moisture at plant and tree root zones for each program the day before the longest no water interval of a new irrigation cycle for each program to verify proper scheduling.
   d. Activation. Contractor to test, repair and turn on irrigation system for seasonal operation in spring.

i. Install and open quick coupler valves at all mainline terminations to safely vent stored compressed air energy.
ii. Turn on the point of connection and valves to fill the mainline. When mainlines filled and air purged; close and remove quick coupler valves.
iii. Inspect the irrigation point of connection assembly and mainline for leaks.
iv. Inspect and electronically operate individual irrigation zones. Adjust irrigation sprinklers and plants as necessary to provide full coverage. Repair any damage with the exception of failures or repairs to the irrigation system resulting from acts of nature, vandalism, or other accidents at no fault of the contractor, and notify the UW. UW shops may make repairs but if they lack capacity, the contractor shall notify the UW to review the damage, agree upon the scope of repair work, and the contractor shall procure and execute the repairs within 5-business days after identifying the damage and UW declining the work, or as agreed to between the contractor and UW. The UW will furnish a purchase order for the repairs based on a contractor quote based on market rates and prevailing wage requirements. Note that the contractor is responsible for providing temporary irrigation as needed until repairs are complete. All repairs shall be made with original equipment.

e. Winterization

i. Contractor to winterize the irrigation system during fall.

(a) Contractor to turn off all major components of irrigation system.
(b) Winterization will be performed by experienced personnel only. Sprinkler system will be winterized before freezing occurs to avoid damage. Extreme care must be taken when blowing out the system to avoid excessive pressure which my damage valves or sprinkler pipe or cause physical injury. Air pressure must not exceed 60 pounds PSI. Close gate valve downstream of master valve and flow sensor. Air compressor capable of providing 10 to 25 CFM of air volume will be introduced into the mainline with a quick coupler key into a quick coupler valve with a second quick coupler key fitted with a bronze full port ball valve inserted into a quick coupler valve at all mainline terminations to act as a safety air vent. Compressor will be turned on, gradually increasing air flow, initially purging the mainline of water, then activating the zone to purge it of water until the sprinklers only expel a fine mist and air. Repeat the process as necessary. After blowing out all zones, the safety air vent quick couplers will be opened while shutting down the compressor. Controller power should remain on but adjust the controller to a no irrigation setting.
(c) Contractor to notify owner that winterization process is completed.

3.08 CLEANING

A. Keep project site reasonably free from accumulation of debris, topsoil and other materials at all times. Maintain pedestrian and driving routes as dictated by the Owner.

B. Remove topsoil and backfill mixes from walks and paving on a daily basis.
C. Remove construction rubbish, broom and hose down areas daily as necessary to maintain clean pavement.
D. After installation and before Substantial Completion, remove nursery tags, nursery stakes, tie tape, labels, wire, burlap, and other debris from plant material, planting areas, and Project site.

3.09 PROTECTION

A. Protect landscape work and materials from damage due to landscape operations, operations by other contractors, trades, and trespassers.
   1. Maintain protection during installation and maintenance periods.
   2. Treat, repair or replace damaged landscape work as directed.

Trees – Standard Specifications

A. Trees

PART 1 – GENERAL

1.01 SUMMARY

A. **This Section specifies minimum requirements** for protection and maintenance of existing trees, shrubs, and other plant materials including lawn surfaces indicated to remain on the Project Site from damage as a result of the Contractor's operations.

B. The scope of work includes all labor, materials, tools, equipment, facilities, transportation and services necessary for, and incidental to performing all operations in connection with protection of existing trees and other plants as shown on the drawings and as specified herein.

1. Marking of clearing limits
2. Protective signage
3. Provide preconstruction evaluations and spec narratives
4. Construction Logistics Plan
5. Provide tree and plant protection fencing
6. Provide protection of root zones and above ground tree and plants
7. Provide pruning of existing trees and plants
8. Coordinate with the requirements of Section Planting Soil for modifications to the soil within the root zone of existing trees and plants
9. Provide maintenance of existing trees and plants including irrigation during the construction period as recommended by the arborist report
10. Provide maintenance of existing trees and plants including irrigation during the post construction pant maintenance period.
11. Remove tree protection fencing and other protection from around and under trees and plants
12. Clean up and disposal of all excess and surplus material

C. Related Sections for References

1. Pre-Design Inventory- Follow University of Washington guidelines for pre-design inventory.
2. References: The following specifications and standards of the organizations and documents listed in this paragraph form a part of the specification to the extent required by the references thereto. In the event that the requirements of the following referenced standards and specification conflict with this specification section the requirements of this specification shall prevail. In the event that the requirements of any of the following

referenced standards and specifications conflict with each other the more stringent requirement shall prevail.

3. ANSI A 300 (Part 5) – Standard Practices for Tree, Shrub and other Woody Plant Maintenance, most current editions.
4. Pruning practices shall conform with recommendations from the most current ISA Standard
5. Glossary of Arboricultural Terms, International Society of Arboriculture, Champaign IL, most current edition.

D. Definitions:

1. Landscape Requiring Protection and Maintenance: All existing tree, plant, and lawn located on the Project Site and not identified for Contractor's lay down or parking use, including trees with root zones extending to or within the Project Site.
2. Critical Root Zone (CRZ): The area equal to one (1) foot radius for every inch diameter from a tree measured at Diameter Standard Height (DSH).
3. Project Arborist: An arborist certified by the International Society of Arborists (ISA) and provided by the Contractor.
4. Dripline: The dripline of a tree is described as the area on the ground beneath the tree's canopy.
5. Owner's Representative: The person appointed by the Owner to represent their interest in the review and approval of the work and to serve as the contracting authority with the Contractor. The Owner's Representative may appoint other persons to review and approve any aspects of the work.
6. Reasonable and reasonably: When used in this specification is intended to mean that the conditions cited will not affect the establishment or long-term stability, health or growth of the plant. This specification recognizes that plants are not free of defects, and that plant conditions change with time. This specification also recognizes that some decisions cannot be totally based on measured findings and that profession judgment is required. In cases of differing opinion, the Owner's Representative expert shall determine when conditions within the plant are judged as reasonable.
7. Shrub: Woody plants with mature height approximately less than 25 feet.
8. Tree and Plant Protection Area: Area surrounding individual trees, groups of trees, shrubs, or other vegetation to be protected during construction, and defined by a circle centered on the trunk with each tree with a radius equal to the clown dripline unless otherwise indicated by the owner's representative.
9. Tree: Single and multi-stemmed plants, including palms with anticipated mature height approximately greater than 25 feet or any plant identified on the plans as a tree.

1.02 SUBMITTALS

It is the intent of this section that the requirements apply to all sections of the project specification such that any subcontractor must comply with the restrictions on work within designated Tree and Plant Protection Areas.

A. Specifications, General Conditions and Drawings: The intent of these documents is to include all labor, materials, and services necessary for the proper execution of the work. The documents are to be considered as one. Whatever is called for by any parts shall be as binding as if called for in all parts.
B. Tree and Landscape Protection Plan: Prior to proceeding with any site disturbance submit a plan to protect all trees, plants, and lawn indicated to remain developed by the Project Arborist, and the name and certification credentials of the proposed Contractor's Project Arborist for Owner's review and approval.

   1. Tree and Landscape Protection Plan to include:
   2. Proposed protection fence locations.

      a. Proposed pedestrian detours to avoid desire routes through landscapes outside the construction fence.
      b. The location of all on-site trees requiring protection identified by number as indicated by the University of Washington, Seattle Campus Tree Inventory Tags.
      c. Identification of the CRZ for each tree requiring protection.
      d. Temporary irrigation and fertilization schedule.

C. Arborist Report: Prior to the start of construction, submit, for approval by the Owner's Representative, the report of a consulting arborist who is a registered Consulting Arborist® (RCA) with American Society of Consulting Arborists or an ISA Board Certified Master Arborist, which details the following information for all trees to remain within the area designated on the drawings as the Tree and Plant Protection Area. Prior to conducting the site visit, obtain a preliminary template from the University of Washington indicating the tree numbers, species, and approximate measurements. Use the UW tree numbers in the Arborist Report. Trees missing numbers should be given a "Letter" description and cross referenced with the University of Washington inventory to either, replace the original number or create a new number. The arborist report shall include the following:

   1. A description of each tree to remain indicating its tree number, genus and species, , condition including any visible damage to the root system or soil within the root zone, tree diameter at standard height (dsh) and approximate height, size and any visible disease, insect infestations and or branch and trunk structural deficiencies.
   2. The report shall note all trees or parts of trees, which are considered a hazard or significant or extreme risk level. Include the International Society of Arboriculture hazard evaluation sheet for each tree, which may reasonably be identified as a potential hazard tree.
   3. Recommendations for fertilizer treatments, if any.
   4. A plan of the site showing the location of all trees included in the report, highlighting any existing Trees of Distinction or Memorial Benches.

D. Product Data: Submit manufacturer product data and literature describing all products required by this section to the Owner's Representative for approval. Provide submittal four weeks before the start of any work at the site.
E. Qualification Submittal: For each applicable person expected to work on the project, provide copies of the qualifications and experience of the Consulting arborist, proof of either the

registered Consulting Arborist® (RCA) with American Society of Consulting Arborists or an ISA Board Certified Master Arborist and any required Herbicide/Pesticide license to the Owner's Representative, for review prior to the start of work.

1.03 CONTRACTOR RESPONSIBILITY

A. Damage: The Contractor shall be responsible for all damage and/or disturbance within the CRZ of landscape indicated to remain including, but not limited to, against cutting, breaking or skinning of roots, skinning or bruising of bark, compaction of root zones and breaking of branches. The Contractor shall assume all trees, plants, and lawn within the Project Site shall be protected unless designated to be removed in the Contract Documents.

1. Damage and/or disturbance which, in the Owner's sole judgment, can be remedied by corrective maintenance shall be immediately repaired by the Contractor upon written notice by Owner.
    a. The Contractor shall employ a licensed arborist to repair damage to trees.
2. Trees or shrubs which are injured or irreparably damaged in usefulness or appearance shall, at the Owner's sole discretion, be replaced by the Contractor with new trees or shrubs of the same size and type.
    a. Trees which fail to fully foliate in the spring following completion of construction operations may be presumed to have been injured or irreparably damaged due to construction operations.
3. If, in the Owner's sole opinion, replacement of damaged trees is determined not feasible or impractical the full replacement costs shall be borne by the Contractor at values based upon the square inches of cross sectional area of trunk measured at standard height, in accordance with the following criteria:
    a. $75.00/square inch for trees less than or equal to 6 inch diameter
    b. $50.00/square inch for trees greater than 6 inch and less than 18 inch diameter
    c. $40.00/square inch for trees greater than or equal to 18 inch diameter
    d. Cost is doubled for Trees of Distinction
4. Damaged trees or shrubs which require removal and/or replacement due to injury or damage by construction operations shall be removed to a depth of two (2) feet below grade and include the refilling and repair of the ground surface, with such costs to be borne by the Contractor.
    a. The Owner is not bound to replace lost trees or shrubs in the same location.
5. Protection and maintenance shall include, but not be limited to, replacement of damaged protection fencing, aeration of compacted soils, control of temporary irrigation water runoff, pruning and treatment of damaged roots, and replacement of wood chips within tree protection areas.
6. Site damage and/or disturbance caused by the Contractor beyond the Project Site shall be repaired or replaced and all costs for such repair shall be borne by the Contractor.

a. Repairs include, but are not limited to, pruning or removing damaged vegetation, replacement of damaged vegetation, and restoration of lawn and ground to its original condition.

B. Verification: All scaled dimensions on the drawings are approximate. Before proceeding with any work, the Contractor shall carefully check and verify all dimensions and quantities, and shall immediately inform the Owner's Representative of any discrepancies between the information on the drawings and the actual conditions, refraining from doing any work in said areas until given approval to do so by the Owner's Representative.

C. Permits and Regulations: The Contractor shall obtain and pay for all permits related to this section of the work unless previously excluded under provision of the contract or general conditions. The Contractor shall comply with all laws and ordinances bearing on the operation or conduct of the work as drawn and specified. If the Contractor observes that a conflict exists between permit requirements and the work outlined in the contract documents, the Contractor shall promptly notify the Owner's Representative in writing including a description of any necessary changes and changes to the contract price resulting from changes in the work.

1. Wherever references are made to standards or codes in accordance with which work is to be performed or tested, the edition or revision of the standards and codes current on the effective date of this contract shall apply, unless otherwise expressly set forth.

a. In case of conflict among any referenced standards or codes or between any referenced standards and codes and the specifications, the more restrictive standard shall apply or Owner's Representative shall determine which shall govern.

D. Protection of work, Property and Person: The Contractor shall protect the work, adjacent property, and the public, and shall be responsible for any damages or injury due to his/her actions.

E. Changes in work: The Contractor shall re-execute any work that fails to conform to the requirements of the contract and shall remedy defects due to faulty materials or workmanship upon written notice from the Owner's Representative, at the soonest possible time that can be coordinated with other work and seasonal weather demands.

1.04 PRECONSTRUCTION CONFERENCE

A. Schedule a pre - construction meeting with the Owner's Representative at least seven (7) days before beginning work to review any questions the Contractor may have regarding the work, administrative procedures during construction and project work schedule.

1. The following Contractors shall attend the preconstruction conference:

a. General Contractor
b. Consulting Arborist
c. Subcontractor assigned to install Tree and Plant Protection measures
d. Earthwork Contractor
e. All site utility Contractors that may be required to dig or trench into the soil
f. Landscape subcontractor

g. Irrigation subcontractor
h. University of Washington Arborist
i. University of Washington Landscape Architect
j. Design Landscape Architect
k. University of Washington Irrigation Lead

2. Prior to this meeting, mark all trees and plants to remain and or be removed as described in this specification for review and approval by the Owner's Representative.
3. Prior to the start of site work including the arrival of temporary facilities and equipment, on-site materials, construction parking, and the commencement of any site clearing, the Contractor shall arrange an on-site pre-installation meeting with the Owner's Representative to identify and stake out all areas of trees, plants, and lawn that are to be protected or removed
4. The Contractor shall be responsible for all damage to landscape features that result from the failure to schedule the pre-installation meeting.

1.05 QUALITY ASSURANCE

A. Contractor Qualifications:

1. All pruning, branch tie back, tree removal, root pruning, and fertilizing required by this section shall be performed by or under the direct supervision of ISA Certified Arborist Submit aforementioned individual's qualifications for approval by the Owner's Representative.
2. All applications of pesticide or herbicide shall be performed by a person maintaining a current state license to apply chemical pesticides valid in the jurisdiction of the project. Submit copies of all required state licensing certificates including applicable chemical applicator licenses. Submit herbicide or pesticide product information for approval prior to application.

B. Observation of Work: Owner's Representative may inspect the work at any time.

PART 2 – PRODUCTS

2.01 TREE PROTECTION

A. Signage:

1. The Contractor shall post weather resistant 8 1/2" x 11" using the UW Protect Tree Template
2. Signs: 8.5 inches x 11 inches, the signs shall be attached to the tree protection fence every 20-foot interval.
3. Information will include UW Project Manager's phone number and tree assessed value.

B. Fencing:

1. Protection fencing shall be equal to the following:

a. CHAIN LINK FENCE: 6 feet tall Galvanized, 11 gauge, 2 inch mesh chain link fencing with nominal 2 1/2 inch diameter galvanized steel posts set in metal frame panels on movable core drilled concrete blocks of sufficient size to hold the fence erect in areas of existing paving to remain.
b. PLASTIC MESH FENCE: Heavy - duty orange plastic mesh fencing fabric 48 inches wide. Fencing shall be attached to metal "U" or "T" post driven into the ground of sufficient depth to hold the fabric solidly in place without sagging. The fabric shall be attached to the post using attachment ties of sufficient number and strength to hold up the fabric without sagging. The Owner's Representative may request, at any time, additional post, deeper post depths and or additional fabric attachments if the fabric begins to sag, lean or otherwise not present a sufficient barrier to access.
c. GATES: For each fence type and in each separate fenced area, provide a minimum of one 3-foot-wide gate. Gates shall be lockable. The location of the gates shall be approved by the Owner's Representative.

2. Submit supplier's product data that product meets the requirements for approval.

2.02 SOIL AND COMPACTION PROTECTION

A. Wood Chips

1. Wood chips shall be composted for a minimum of one (1) year.
2. Wood Chips from an arborist chipping operation with less than 20% by volume green leaves. Chips stockpiled from the tree removal process may be used.
3. Mulch shall be coarse, ground, from tree and woody brush sources. The minimum range of fine particles shall be 3/8 inch or less in size and a maximum size of individual pieces shall be approximately 1 to 1-1/2 inch in diameter and maximum length of approximately 4 to 8 inches. No more that 25% of the total volume shall be fine particles and no more than 20% of total volume be large pieces.

Submit supplier's product data that product meets the requirements and two-gallon sample for approval.

B. Matting

1. Matting for vehicle and work protection shall be heavy duty matting designed for vehicle loading over tree roots, Alturnamats as manufactured by Alturnamats, Inc, Franklin, PA 16323 or approved equal.
2. Submit supplier's product data that product meets the requirements for approval.

C. Geogrid

1. Geogrid shall be woven polyester fabric with PVC coating Uni-axial or biaxial geogrid, inert to biological degradation, resistant to naturally occurring chemicals, alkalis, and acids.
2. Geogrid shall be Miragrid 2XT as manufactured by Ten Cate Nicolon, Norcross, GA. www.tencate.com or approved equal.

   a. Submit suppliers product data that product meets the requirements for approval.

D. Filter Fabric

1. Filter Fabric shall be nonwoven polypropylene fibers, inert to biological degradation and resistant of naturally occurring chemicals, alkalis and acids.

    a. Mirafi 135 N as manufactured by Ten Cate Nicolon, Norcross, GA. www.tencate.com or approved equal.

2. Submit suppliers product data that product meets the requirements for approval

E. Fertilizer

1. Fertilizer shall be Osmocote Plus, 15-9-12 or approved equal.

PART 3 – EXECUTION

3.01 SITE EXAMINATION AND COORDINATION

A. Examine the site, tree, plant and soil conditions. Notify the Owner's Representative in writing of any conditions that may impact the successful Tree and Plant Protections that is the intent of this section.

B. The Contractor shall coordinate with all other work that may impact the completion of the work.

1. Prior to the start of work, prepare a detailed schedule of the work for coordination with other trades.
2. Coordinate the relocation of any irrigation lines currently present on the irrigation plan, heads or the conduits of other utility lines or structures that are in conflict with tree locations. Root balls shall not be altered to fit around lines. Notify the Owner's Representative of any conflicts encountered. Coordinate tree planting with minimum setbacks from mainlines, electrical, fire hydrant, lightposts and other utilities.

3.02 TREE AND PLANT PROTECTION AREA

A. The Tree and Plant Protection Area is defined as all areas indicated on the tree protection plan. Where no limit of the Tree and Plant Protection area is defined on the drawings, the limit shall be the drip line (outer edge of the branch crown) of each tree.

B. Preparation:

1. Prior to the preconstruction meeting, layout the limits of the Tree and Plant Protection Area and then alignments of required Tree and Plant Protection Fencing and root pruning. Obtain the Owner's Representative's approval of the limits of the protection area and the alignment of all fencing and root pruning.
2. Flag all trees and shrubs and obtain the Owner Representative's approval of all trees and shrubs to be removed prior to the start of tree and shrub removal.
3. After approval, mark all trees to be removed in orange paint in a band at the base of the tree. Mark all shrubs with orange paint.

4. The Owner's Representative will determine which trees to salvage. Mark all salvage trees with an "X" in white paint and follow Salvage Wood instruction.
5. Prior to any construction activity at the site including utility work, grading, storage of materials, or installation of temporary construction facilities, install all tree protection fencing, Filter Fabric, silt fence, tree protection signs, Geogrid, Mulch and or Wood Chips as shown on the drawings.
6. Prior to any construction activity at the site including utility work, grading, storage of materials, or installation of temporary construction facilities, install all tree protection fencing, Filter Fabric, silt fence, tree protection signs, Geogrid, Mulch and or Wood Chips as shown on the drawings.

C. Root Pruning:

1. Root pruning is the physical cutting of tree roots to minimize root damage and promote healing. Any method which tears roots or disturbs the soil beyond the grading limit is unacceptable.
   a. Root prune using a sharpened spade, hand pruners or loppers for all roots smaller than one inch diameter.
   b. Root prune using an ax, sawz-all, or chainsaw for all roots greater than one inch diameter.
   c. Do not use a backhoe bucket or any other excavating machine to root prune.
   d. Do not allow roots to dry out. Use moistened burlap to keep roots wet until the roots are cut clean and covered with soil or wet mulch.
2. When construction is in close proximity to existing trees to remain, and roots are encountered, the roots shall be pruned by the Project Arborist.
   a. Root pruning shall be performed as early as possible before trenching or tunneling operations.
   b. Hand-dig trenches in areas with extensive roots.
   c. Leave intact and undamaged roots larger than two (2) inches in diameter. Do not pull roots. During the time of exposure, keep roots moist with wet mulch and burlap or equivalent.
3. Backfill trenches that require root pruning with existing soil mixed with peat moss to a mixture of approximately 75% loam and 25% humus by volume. Tamp soil in six-inch lifts. Each lift shall be compacted to a point at which a foot print makes only a 1/16 inch impression.
4. Apply mulch to a depth of four (4) inches at a minimum ten (10) to fifteen (15) foot radius around tree to reduce compaction and increase moisture retention.

D. Installation of geogrids, filter fabric, matting, wood chips and or mulch

1. Install Geogrids, Filter Fabric, matting, Wood Chips and or Mulch in areas and depths shown on the plans and details or as directed by the Owner's representative. In general it is the intent of this specification to provide the following levels of protection:

a. All areas within the Tree and Plant Protection area provide a minimum of 5 inches of Wood Chips or Mulch.
b. Areas where foot traffic or storage of lightweight materials is anticipated to be unavoidable provide a layer of Filter Fabric under the 5 inches of Wood Chips or Mulch.
c. Areas where occasional light vehicle traffic is anticipated to be unavoidable provide a layer of Geogrids under 8 inches of Wood Chips or Mulch.
d. Areas where heavy vehicle traffic is unavoidable provide a layer of Geogrids under 8 - 12 inches of Wood Chips or Mulch and a layer of matting over the Wood Chips or Mulch.

2. The Owner's Representative shall approve the appropriate level of protection.
3. In the above requirements, light vehicle is defined as a track skid steer with a ground pressure of 4 psi or lighter. A heavy vehicle is any vehicle with a tire or track pressure of greater than 4 psi. Lightweight materials are any packaged materials that can be physically moved by hand into the location. Bulk materials such as soil, or aggregate shall never be stored within the Tree and Plant Protection Area.

E. Installation of tree protection fencing

1. Install posts a minimum of two (2) feet below grade and spaced ten (10) feet on center maximum.
2. Provide diagonal bracing to posts at corners of enclosures and whenever needed to ensure rigidity of the fencing.
3. Install chain link fencing tight to grade at the bottom edge and stretched uniformly between posts.
4. Provide one gate into each fenced area.
5. Attach orange flag strips 12” long at 3’ on center along the fence and five (5) feet above grade.
6. Take care not to damage roots or to compact soil inside the fence line during placement of posts. Do not use heavy equipment for this operation.
7. Alter no grades within protective fencing except as approved by the Tree and Landscape Protection Plan, during the fine grading operations at the conclusion of site development.

F. Protection of existing trees and shrubs

1. Protect the Tree and Plant Protection Area at all times from compaction of the soil; damage of any kind to trunks, bark, branches, leaves and roots of all plants; and contamination of the soil, bark or leaves with construction materials, debris, silt, fuels, oils, and any chemicals substance. Notify the Owner’s Representative of any spills, compaction or damage and take corrective action immediately using methods approved by the Owner’s Representative.

2. Trees indicated to remain within the Project Site shall have protection fencing or tree trunk boxing that shall be maintained by the Contractor in good condition until Substantial Completion.

3. Protection fencing shall be located at the Critical Root Zone (CRZ). The area equal to one (1) foot radius for every inch diameter from a tree measured at Diameter Standard Height (DSH).
4. When no ground vegetation exists within the CRZ of a tree indicated for protection, the ground shall be protected with a minimum of twelve (12) inches of wood chips that extends with a three (3) foot radius clear zone from each truck.
5. Buildings, retaining wall or other appropriate hardscape me be utilized as tree protection fencing with approval from the Owner's Representative.
6. Existing trees that are not protected with fencing and are to remain shall be protected by boxing.

   a. Boxing shall be 4 inch x 4 inch with two – 2 inch x 4 inch rails. Box shall be approximately 8 feet x 8 feet in size centered on the tree trunk to a height of approximately 6 feet.

G. General requirements and limitations for operations within the tree and plant protection area:

1. The Contractor shall not engage in any construction activity within the Tree and Plant Protection Area without the approval of the Owner's Representative including: operating, moving or storing equipment; storing supplies or materials; locating temporary facilities including trailers or portable toilets and shall not permit employees to traverse the area to access adjacent areas of the project or use the area for lunch or any other work breaks. Permitted activity, if any, within the Tree and Plant Protection Area maybe indicated on the drawings along with any required remedial activity as listed below.
2. In the event that construction activity is unavoidable within the Tree and Plant Protection Area, notify the Owner's Representative and submit a detailed written plan of action for approval. The plan shall include: a statement detailing the reason for the activity including why other areas are not suited; a description of the proposed activity; the time period for the activity, and a list of remedial actions that will reduce the impact on the Tree and Plant Protection Area from the activity. Remedial actions shall include but shall not be limited to the following:

   a. In general, demolition and excavation within the CRZ of trees and shrubs shall proceed with extreme care either by the use of hand tools, directional boring and or Air Spade, vacuum truck excavation where indicated or with other low impact equipment that will not cause damage to the tree, roots or soil.
   b. When encountered, exposed roots, 2 inches and larger in diameter shall be worked around in a manner that does not break the outer layer of the root surface (bark). These roots shall be covered in Wood Chips and shall be maintained above permanent wilt point at all times. Roots two inches and larger in diameter shall not be cut without the approval of the owners representative. Excavation shall be tunneled under these roots without cutting them. In the areas where roots are encountered, work shall be performed and scheduled to close excavations as quickly as possible over exposed roots.

c. Tree branches that interfere with the construction may be tied back or pruned to clear only to the point necessary to complete the work. Other branches shall only be removed when specifically indicated by the Owner's Representative. Tying back or trimming of all branches and the cutting of roots shall be in accordance with accepted arboricultural practices (ANSI A300, part 8) and be performed under supervision of the arborist.
d. Matting: Install temporary matting over the Wood Chips or Mulch to the extent indicated. Do not permit foot traffic, scaffolding or the storage of materials within the Tree and Plant Protection Area to occur off of the temporary matting.
e. Air Excavation Tool: If excavation for footings or utilities is required within the Tree and Plant Protection Area, air excavation tool techniques shall be used where practical or as designed on the drawings.

    i. Remove the Wood Chips from an area approximately 18 inches beyond the limits of the hole or trench to be excavated. Cover the Wood Chips for a distance of not less than 15 feet around the limit of the excavation area with Filter Fabric or plastic sheeting to protect the Wood Chips from silt. Mound the Wood Chips so that the plastic slopes towards the excavation.
    ii. Using a sprinkler or soaker hose, apply water slowly to the area of the excavation for a period of at least 4 hours, approximately 12 hours prior to the work so that the ground water level is at or near field capacity at the beginning of the work. For excavations that go beyond the damp soil, rewet the soil as necessary to keep soil moisture near field capacity.
    iii. Using an air excavation tool specifically designed and manufactured for the intended purpose, and at pressures recommended by the manufacturer of the equipment, fracture the existing soil to the shape and the depths required. Work at rates and using techniques that do not harm tree roots. Air pressure shall be a maximum of 90-100 psi.

        (a) The air excavation tool shall be "Air-Spade" as manufactured by Concept Engineering Group, Inc., Verona, PA (412) 826-8800, or Air Knife as manufactured by Easy Use Air Tools, Inc. Allison Park, Pa (866) 328-5723 or approved equal.

f. Using a commercial, high-powered vacuum truck if required, remove the soil from the excavation produced by the Air Knife excavation. The vacuum truck should generally operate simultaneously with the hose operator, such that the soil produced is picked up from the excavation hole, and the exposed roots can be observed and not damaged by the ongoing operation. Do not drive the vacuum truck into the Tree and Plant Protection Area unless the area is protected from compaction as approved in advance by the Owner's Representative.

    i. Remove all excavated soil and excavated Wood Chips, and contaminated soil at the end of the excavation.
    ii. Schedule the work so that foundations or utility work is completed immediately after the excavation. Do not let the roots dry out. Mist the roots

several times during the day. If the excavated area must remain open overnight, mist the roots and cover the excavation with black plastic.

iii. Dispose of all soil in a manner that meets local laws and regulations.

iv. Restore soil within the trench as soon as the work is completed. Utilize soil of similar texture to the removed soil and lightly compact with hand tools. Leave soil mounded over the trench to a height of approximately 10% of the trench depth to account for settlement.

v. Restore any Geogrids, Filter Fabric, Wood Chips or Mulch and or matting that was previously required for the area.

3.04 PRUNING

A. All pruning shall be done in accordance with ANSI A300 (part 1), ISA BMP Tree Pruning (latest edition, and the "Structural Pruning: A Guide for the Green Industry", Edward Gilman, Brian Kempf, Nelda Matheny and Jim Clark, 2013 Urban Tree Foundation, Visalia CA.

B. Within six months of the estimated date of substantial completion, prune all dead or hazardous branches larger than 1 inch in diameter from all trees to remain.

C. Implement all pruning recommendations found in the arborist report and all pruning of damaged trees shall be carried out under the supervision of the Project Arborist.

D. Prune any low, hanging branches and vines from existing trees and shrubs that overhang walks, streets and drives, or parking areas as follows:

   1. Walks - within 8 feet vertically of the proposed walk elevation.
   2. Parking areas - within 12 feet vertically of the proposed parking surface elevation.
   3. Streets and drives - within 14 feet vertically of the proposed driving surface elevation.

E. Perform other pruning task as indicated on the drawings or requested by the Owner's Representative.

F. Sterilize all pruning tools between the work in individual trees.

3.05 TREE AND STUMP REMOVAL

A. Tree Removal

   1. Remove all trees indicated by the drawings and specifications, as requiring removal, in a manner that will not damage adjacent trees or structures or compacts the soil.
   2. Remove trees that are adjacent to trees or structures to remain, in sections, to limit the opportunity of damage to adjacent crowns, trunks, ground plane elements and structures.
   3. Do not drop trees with a single cut unless the tree will fall in an area not included in the Tree and Plant Protection Area. No tree to be removed within 50 feet of the Tree and Plant Protection Area shall be pushed over or up-rooted using a piece of grading equipment.
   4. Protect adjacent paving, soil, trees, shrubs, ground cover plantings and understory plants to remain from damage during all tree removal operations, and from construction operations. Protection shall include the root system, trunk, limbs, and crown from breakage or scarring, and the soil from compaction.

B. Salvage Wood

5. Salvage Trees marked with a white "X". Logs must be relatively straight with a minimum diameter of 18" and a length between 4 feet – 11ft. 6 inches. Each log must be marked with a permanent tree tag at the cut log end indicating the tree number. Tags may be provided by the University of Washington.

C. Stump Removal

1. Remove stumps and immediate root plate from existing trees to be removed. Grind trunk bases and large buttress roots to a depth of the largest buttress root or at least 18 inches below the top most roots whichever is less and over the area of three times the diameter of the trunk (DBH).
2. For trees where the stump will fall under new paved areas, grind roots to a total depth of 18 inches below the existing grade. If the sides of the stump hole still have greater than approximately 20% wood visible, continue grinding operation deeper and or wider until the resulting hole has less than 20% wood. Remove all wood chips produced by the grinding operation and back fill in 8 inch layers with controlled fill of a quality acceptable to the site engineer for fill material under structures, compacted to 95% of the maximum dry density standard proctor. The Owner's Representative shall approve each hole at the end of the grinding operation.
3. In areas where the tree location is to be a planting bed or lawn, remove all woodchips and backfill stump holes with planting soil as defined in Specification Section Planting Soil, in maximum of 12 inch layers and compact to 80 - 85% of the maximum dry density standard proctor.

3.06 FERTILIZING AND IRRIGATION DURING CONSTRUCTION/MAINTENANCE PERIOD

A. All trees and landscape requiring protection shall be fertilized and watered by the Contractor until Substantial Completion.

1. Fertilize and irrigate per the approved Tree and Landscape Protection Plan.
2. Water used for irrigation shall be potable water supplied by the Contractor.

B. Soil Moisture: Volumetric soil moisture level, in all soils within the Tree and Plant Protection Area shall be maintained above permanent wilt point to a depth of at least 8 inches. No soil work or other activity shall be permitted within the Tree and Plant Protection Area when the volumetric soil moisture is above field capacity. The permanent wilt point and field capacity for each type of soil texture shall be defined as follows (numbers indicate percentage volumetric soil moisture).

Soil type	Permanent wilt point v/v	Field capacity v/v
Sand, Loamy sand, Sandy loam	5-8%	12-18%

Loam, Sandy clay, Sandy clay loam	14-25%	27-36%
Clay loam, Silt loam	11-22%	31-36%
Silty clay, Silty clay loam	22-27%	38-41%

C. The Contractor shall confirm the soil moisture levels at the request of the owner. If the moisture is too high, suspend operations until the soil moisture drains to below field capacity.

D. The Contractor shall be fully responsible to ensure that adequate water is provided to all plants to be preserved during the entire construction period. Adequate water is defined to be maintaining soil moisture above the permanent wilt point to a depth of 8 inches or greater.

E. The Contractor shall adjust the automatic irrigation system, if available, and apply additional water, using hoses or water tanks as required.

F. Periodically test the moisture content in the soil within the root zone to determine the water content.

3.07 GENERAL MAINTENANCE DURING CONSTRUCTION/MAINTENANCE PERIOD

A. Weed Removal

1. During the construction period, control any plants that seed in and around the fenced Tree and Plant Protection area at least twice a month between during November-March and weekly April-October.
2. At the end of the construction period provide one final weeding of the Tree and Plant Protection Area.

B. Insect and Disease Control

1. Monitor all plants to remain for disease and insect infestations during the entire construction period. Provide all disease and insect control required to keep the plants in a healthy state using the principles of Integrated Plant Management (IPM). All pesticides shall be applied by a certified pesticide applicator and pre-approved by the owner's representative.

C. Clean-up

1. During tree and plant protection work, keep the site free of trash, pavements reasonably clean and work area in an orderly condition at the end of each day. Remove trash and debris in containers from the site no less than once a week.

   a. Immediately clean up any spilled or tracked soil, fuel, oil, trash or debris deposited by the Contractor from all surfaces within the project or on public right of ways and neighboring property.

2. Once tree protection work is complete, wash all soil from pavements and other structures. Ensure that Mulch is confined to planting beds.
3. Make all repairs to grades, ruts, and damage to the work or other work at the site.
4. Remove and dispose of all excess Mulch, Wood Chips, packaging, and other material brought to the site by the Contractor.
5. Do not store materials potentially harmful to tree roots within twenty (20) feet of protection fencing. Potentially harmful materials include, but are not limited to, petroleum products, cement and concrete materials, cement additives, lime, paints and coatings, waterproofing products, concrete forms coatings, detergents, acids, and cleaning agents.

3.08 REMOVAL OF TREE/PLANT PROTECTION: DAMAGE OR LOSS MITIGATION

A. At the end of the construction period or when requested by the Owner’s Representative remove all fencing, Wood Chips or Mulch, Geogrids and Filter Fabric, trunk protection and or any other Tree and Plant Protection material.

B. Any trees or plants designated to remain, and which are damaged by the Contractor shall be replaced in kind by the Contractor at their own expense. Trees shall be replaced with a tree of similar species and of equal size or 6 inch caliper whichever is less. Shrubs shall be replaced with a plant of similar species and equal size or the largest size plants reasonably available whichever is less. Where replacement plants are to be less than the size of the plant that is damaged, the Owner’s Representative shall approve the size and quality of the replacement plant.

   1. All trees and plants shall be installed per the requirements of Specification Section Planting.

C. Plants that are damaged shall be considered as requiring replacement or appraisal in the event that the damage affects more than 25 % of the crown, 25% of the trunk circumference, or root protection area, or the tree is damaged in such a manner that the tree could develop into a potential hazard. Trees and shrubs to be replaced shall be removed by the Contractor at his own expense.

   1. The Owner's Representative may engage an independent arborist to assess any tree or plant that appears to have been damaged to determine their health or condition.

D. Any tree that is determined to be dead, damaged or potentially hazardous by the Owner’s arborist and upon the request of the Owner’s Representative shall be immediately removed by the Contractor at no additional expense to the owner. Tree removal shall include all cleanup of all wood parts and grinding of the stump to a depth sufficient to plant the replacement tree or plant, removal of all chips from the stump site and filling the resulting hole with topsoil.

E. Any remedial work on damaged existing plants recommended by the consulting arborist shall be completed by the Contractor at no cost to the owner. Remedial work shall include but is not limited to: soil compaction remediation and vertical mulching, pruning and or cabling, insect and disease control including injections, compensatory watering, additional mulching, and could include application tree growth regulators (TGR).

F. Remedial work may extend up to two years following the completion of construction to allow for any requirements of multiple applications or the need to undertake applications at required seasons of the year.

Exterior Improvements – Irrigation

A. Irrigation

Basis of Design

This section applies to the design and installation of underground irrigation systems for landscaped areas, lawns, and planting beds.

Design Criteria

1. Refer to University drawings 917RU-01 through 917RU-18 for existing irrigation. These drawings are updated regularly but are schematic and may not be accurate or complete.
2. Irrigation piping flow velocity shall not exceed 5 feet per second.
3. Provide an irrigation system water header with isolation gate valve, wye strainer, deduct meter, pressure reducing valve, backflow preventer (double check valve assembly or reduced pressure backflow preventer), gauges, master valve, flow sensor, quick coupler, drain, and other appurtenances. Where possible, install the water header in an adjacent building. If this is not possible, provide an adequately sized valve vault or individual valve boxes to facilitate equipment repair/maintenance.
4. Irrigation systems with a 3-inch or larger mainline shall be designed to permit gravity drainage.
5. Irrigation system static pressure range shall not vary by more than 10%.
6. Design irrigation system lateral piping to limit pressure drops to less than 20% of the average sprinkler operating pressure.
7. Provide quick coupler valves every 100 feet or less. These quick coupler valves are used to hand water landscaped areas. Locate quick coupler valves to limit water hoses crossing walkways and roads.
8. Install sprinkler heads and nozzle types of the same manufacturer and pressure rating within the same irrigation zone.
9. Zone the irrigation system according to microclimates and plant water requirements. Hydrozone plants with similar water requirements. Zone turf and bed areas separately. Microclimate variables to consider are: slope; on-structure plantings; raised planters; sun and shade exposure with respect to structural shading, plant & tree canopy shading, , and seasonal sun path; reflective and radiant heat exposure; wind exposure and average prevailing wind; rain shadow; soil structure; soil texture/type; plant density and canopy layers; and the impact of plant growth/maturity size. Zones shall not be on more than one side of a building. Provide dedicated tree zones when tree water requirements differ significantly from surrounding shrubs and groundcovers. Hydrozone tree varieties as necessary. For dedicated tree zones, non-polymer time release water gel supplement may be used in lieu of traditional irrigation with approval.
10. Require new plant materials have pots, cages and/or burlap removed, root balls scored and pruned of circular root growth, rootballs soaked in w ater with 1 ounce of Yuccah natural

surfactant per gallon of water prior to planting (to break down surface tension of rootballs and stimulate water transfer between differing import soil and root ball soil interface), then hand watered within 24 hours of planting, and regularly hand watered thereafter in conjunction with automatic irrigation during contractor's maintenance period (typically 60 days), particularly trees.

11. Install a manual shutoff valve to isolate the irrigation system from the water supply main.
12. Design irrigation systems to avoid overspray, avoid spray blockage from adjacent aboveground utilities (e.g., electric transformers, light standards, etc.), and avoid misting from excessive pressure.
13. Locate irrigation system spray heads located adjacent to parking lot curbs on-center with parking stall striping to prevent damage to the irrigation system from vehicles.
14. Consider surrounding areas affected by the work. For existing systems work limit, design and specify to protect, restore and/or alter to proper working order. Consider utilizing existing irrigation systems and components. Demo existing irrigation to be supplanted by new irrigation by capping and removing whenever possible. When necessary to abandon piping in place, as in the case of it being within the root zones of trees to remain, show it on the as-built drawings and cap all open ends. Provide smooth transitions and balanced coverage between existing and new systems.
15. When there is an alteration to an existing irrigation system, test existing mainline, control valves, lateral lines, sprinklers, drip line and wiring prior to alteration to establish baseline status. Determine mainline static and working pressure, lateral line working pressure, zone flow rate in gallons per minute (GPM), coverage, and electrical circuit continuity testing for control wiring.
16. When extending an existing irrigation system, at transitions between existing & new piping, provide isolation ball valves for laterals and gate valves for mainlines, with accessible enclosures.
17. Sprinkler swing assemblies shall not exceed 24 inches.
18. Design all sprinkler layouts for overlapping head to head coverage. Do not stretch spacing of published sprinkler radii unless no wind conditions. Design all sprinkler layouts at 45 percent of published diameter. In areas of persistent wind, design all rotary sprinkler layouts at 40 percent of published diameter.
19. Provide matched precipitation rates for sprinklers within the same irrigation zone. Separate unmatched precipitation rate rotary sprinklers into zones with common arcs. If necessary to mix diverse arcs of unmatched precipitation rate rotary sprinklers in the same zone. Match precipitation rates when using diverse arcs in the same zone. Use matched precipitation spray and stream nozzles.
20. Design irrigation system so that precipitation rates do not exceed infiltration rates.
21. For interior mechanical rooms, install metallic ball valves upstream and downstream of automatic zone valves and other appurtenances on vertical risers.
22. Provide a minimum of two spare control wires to all remote mainline legs. Additional spares may be requested during design to offer the potential for expansion.
23. Design mainline flow based upon the largest zone GPM combined with a single quick coupler at 20 GPM. Design zones or full rated working pressure for the selected water delivery media with at least one quick coupler at 20 GPM operating simultaneously.

24. Design piping with a horizontal layout on slopes. Reduce the spacing across the slope 1% for every 1% increase in slope beyond 10%.1 Percent of slope equals vertical rise in feet per 100 feet.2 Reduce sprinkler spacing to the actual sprinkler radius at the crown of the slope and increase the spacing at the toe of the slope as to prevent overthrow beyond the bottom boundary of the slope.3 Sprinkler design layout for slopes should be proportionate to the actual lineal feet of the hypotenuse (leg C), which would be misrepresented if scaled in plan view (leg A) resulting in stretched spacing. For clarification, call out actual spacing on the drawings. Do not design with elevation changes that exceed the capacity of sprinkler check valves. (footnotes 1-3 reference Buckner Irrigation Systems Design Manual, 1st Edition 1988, page 2-6.
25. Install sprinklers perpendicular to the average surrounding slope. Firmly tamp and compact soil around sprinkler heads for stability.
26. For drip irrigation for trees, install multiple emitters over rootballs via supplemental looped drip line perpendicular to line layout and/or multiple layers at incremental depths across the root zone, i.e. for a 1.5 foot diameter root ball, install 1st grid scored into soil at a 2 inch depth, the 2nd grid at a 6 inch depth, and the 3rd grid at a10 inch depth.
27. For drip irrigation, score lines 2 inches below soil finish grade and secure with 6 inch staples.
28. Locate valve boxes, valves and quick coupler valves in beds at least 36-inches off hardscape edges.
29. Consider use of captured rainwater or recycled site water to reduce potable water consumption for irrigation.

Design Evaluation

The following information is required to evaluate the design:

1. Programming Phase: Statement of design intent including irrigation area.
2. Schematic Design Phase: Utility connection and irrigation legend.
3. Design Development Phase: Piping plans, controller and header/vault location. Outline and draft specifications.
4. Construction Document Phase: Piping diagrams, pipe diameter, design calculations, and specifications.

Construction Submittals

1. Provide standard industry submittal requirements.
2. Gateway and IP addresses for Ethernet-based irrigation controllers are entered at the factory. The University provides the gateway and IP addresses. Submittal should demonstrate University gateway and IP addresses.

Related Sections

- Facilities Services Design Standard - Earthwork
- Capital Projects Office Design Guide - Landscape
- Facilities Services Design Standard - Civil
- Facilities Services Design Standard - Mechanical
- Facilities Services Design Standard - Electrical

Products, Materials and Equipment

1. Controller: Rain Master Evolution DX2, 6 to 48 station capacity, to tie into existing central control system, with flow/weather board (DX-FLOW), and one of the following hardware options: Ethernet circuit board (DX-ETHER-SM), phone board (DX-PH), or a radio circuit board (DX-RF). Ethernet is preferred, phone can be used where Ethernet is unavailable, and radio can be used where Ethernet and phone are unavailable. Radio communication requires the following additional requirements. A Radio Site Survey shall be conducted and passed by an authorized Rain Master representative. Provide a radio communication board (DX-RF), data radio (EV-RADIO-F) and a low gain antenna (EV-ANT-FD) for line of site, or a high gain antenna (EV-ANT-F) for non line of site applications. No exceptions.
2. Rain Master RME Eagle web-based central control compatible controllers may be used with authorization only (requires alternate central control infrastructure and service charge). No exceptions.
3. For some smaller systems, with approval, non-centralized controllers may be used: Calsense ET2000e; Toro TR3000 battery latching solenoid valve actuators for no power conditions only. Appropriate valve to solenoid adapters must be used, i.e. RainBird PEB uses a Toro TVA-15 valve adapter. Note that a Toro TRCP8 infrared remote may be required. No exceptions.
4. DX-2 Controllers and Enclosures: for exterior wall mounted installation, use stainless steel cabinet (SWM). For interior wall mounted installation, use painted cabinet (PWM). For exterior installation, pedestal cold rolled (CR) enclosures are preferred; use Retro-fit Back Panel controller (RETRO) within V.I.T. 18CR enclosure or Strongbox-18SS with 18CR or PED-18SS pedestals. Provide enclosure and pedestal to UW Irrigation at least three weeks prior to installation to be painted to campus standards by UW Paint Shop.
5. Pressure reducing valves: Watts, Febco, or approved substitution
6. Backflow prevention assemblies
   a. Double-check valve assemblies: Febco 805, Watts, or approved substitution
   b. Reduced pressure backflow prevention assemblies: Watts 909 Series. For exterior applications, use a lockable hotbox to enclose RPBP assembly, provide drainage for reduced pressure discharge, 100 VAC with a GFCI receptacle, and an automatic heating coil to provide the assembly with freeze protection. Required for storm water retention systems, graywater systems, and purple water systems
7. Central control networked master valves: Superior 3300, normally open, sized to accommodate system design flow. . No exceptions
8. Central control networked digital flow sensors:

Exterior	Interior	GPM	Size	Model	Type
Yes	Yes	2 – 40	1-inch	RainMaster FS-B100	Brass
Yes	Yes	2 - 45	1-inch	Data Industrial 250B-1	Brass
Yes	No	2 - 20	1-inch	Data Industrial 220P-1	PVC
Yes	Yes	3 - 60	1.25-inch	RainMaster FS-B125	Brass
Yes	Yes	3 - 90	1.25-inch	Data Industrial 250B-1.25	Brass
Yes	Yes	5 - 100	1.5-inch	RainMaster FS-B150	Brass
Yes	No	5 - 100	1.5-inch	RainMaster FS-150	PVC
Yes	Yes	4 - 100	1.5-inch	Data Industrial 250B-1.5	Brass
Yes	No	8 - 180	1.5-inch	Data Industrial 220P-1.5	PVC
Yes	Yes	10 - 200	2-inch	RainMaster FS-B200	Brass
Yes	No	10 - 200	2-inch	RainMaster FS-200	PVC
Yes	Yes	10 - 250	2-inch	Data Industrial 228B-2	Brass
Yes	No	13 - 250	2-inch	Data Industrial 220P-2	PVC

9. Flow sensor size should be based upon capturing the flow in a range covering the lowest flow zone to the simultaneous operation of the highest flow zone (GPM) at full working pressure and a single quick coupler at 20 GPM. In the case of planned expansion, consider size of future zones in sizing flow sensor.
10. Irrigation Deduct Water Meter: See Mechanical – Metering and Gauges for irrigation deduct meter requirements.
11. Exterior pipe mainline and laterals: PVC, Schedule 40 with solvent weld-type joints Exceptions: (1) where risers, valves, etc. require threaded joints, and (2) use Schedule 80 PVC 10 pipe diameters upstream and 5 pipe diameters downstream of Data Industrial PVC flow sensors. All lateral fittings should be installed with outlets horizontal and facing the exterior of the planting area. Inlet fittings for quick coupler valves shall be installed horizontally. Valve inlet fittings shall be installed vertically.
12. Zone valves: Use RainBird PEB & GB Series automatic control valves. Size so that the midpoint of the valve flow range is approximates the zone (GPM). Size so that optimal psi loss through valve is between 3 and 7 psi. Use PRS-D pressure regulating units for sprinkler zones only. Use PRS-D pressure regulating units per manufacturer's recommendations (see flow & pressure loss chart).
13. Manual zone valves: Brass angle valves with brass cross handles
14. Manual gate valves: 2.5-inch and smaller diameter shall be bronze (ASTM B-62) valve with bronze solid wedge, integral taper seats with a non-rising stem. All valves larger than 2.5-inch diameter shall be threaded iron body, brass trimmed, resilient wedge, integral taper seats with non-rising stem, and square operating nut.
15. Ball valves: KBI Low Torque slip-by-slip, or approved substitution
16. Valve boxes & extensions: Carson with non-hinged cover (black), sized to allow room for testing, manual operation, calibration, removal, maintenance of equipment, and 1-2 inch clearances between piping, valves and valve boxes and 3-4 inches between valves and subgrade/gravel, set on compacted subgrade with masonry units under each corner; seal openings with filter fabric

affixed to outside of valve box. Size as follows: gate valve – 910; wye strainer – 1419 (1.5 inch), 1220 (2 inch), backflow assemblies – 1730; master valve – 1419; flow sensor – 1410; point of connection quick coupler valve – 910; automatic control valves – 1220 (1 inch), 1324 (1.25 inch and above). Set on masonry units at each corner. For gate valves in landscape, use 8 inch PVC vertical sleeve (sanitary non pressure rated okay); ensure sleeve is plumb, center valve in sleeve, set top of sleeve 2 inches below bottom of valve box lid (when in closed position), cut notch in sleeve to straddle supply piping with at least 1-2 inches clearance, set sleeve on 2 masonry units on compacted subgrade (not touching piping), seal gaps with filter fabric affixed to outside of sleeve. For gate valves in hardscapes, use cast iron frames and lids. For exterior multiple valve manifolds, use of a concrete enclosure with metal hinged lid (may be necessary (traffic rated if applicable). No exceptions.

17. Sprinkler heads:
    a. Pop-up spray or steam spray sprinklers
        i. RainBird 1800-sam-prs with standard screens and nozzles. Use 4-inch risers in regular turf, 6-inch risers in eco-turf with approval, and 12-inch risers in beds. For increased trajectory, as to clear plant materials, use longer radius nozzles and reduce radii as necessary with pressure compensating screens. Call out screen color and type. Calculate adjusted precipitation rates and match with other nozzles on the same zone.
    b. Short range rotary sprinklers
        i. MP Rotator matched precipitation rate nozzles: corner, end strip, side strip, 1000, 2000; to be installed on RainBird 1800 Series sprinkler bodies with SAM feature; only use PRS feature when desired radii can be achieved with 30 psi of less.
        ii. Hunter I-20 Ultra with SR Series nozzles
        iii. Toro 300 Series stream rotors with 01, 02 Series nozzles; no Omni Adjustable nozzles; include in-line check valves on downstream end of swing assembly but upstream of Marlex ell.
    c. Medium range rotary sprinklers
        i. MP Rotator matched precipitation rate nozzles: 3000 Series; to be installed on RainBird 1800 Series sprinkler bodies with SAM feature; only use PRS feature when desired radii can be achieved with 30 psi of less.
        ii. Hunter I-20 Ultra with stainless steel riser in turf applications and plastic risers in bed applications. Use low angle nozzles when necessary for areas prone to wind.
        iii. Toro 300 Series stream rotors with 03 nozzles; no Omni Adjustable nozzles.
    d. Long range rotary sprinklers
        i. Hunter I-40 with stainless steel riser
18. Alternate Water Delivery Media:
19. RainBird IS Series Irrigation Supplement: Non polymer time release microbial activated water gel with approval. Uses may include remote plantings and/or in lieu of a dedicated tree zone comprised of conventional irrigation. Swing Joints:
    a. ½-inch inlet sprinklers: Hunter SJ-512 with additional top and bottom ½-inch Marlex street ells.

b. 3/4-inch inlet sprinklers: For flow less or equal to 6 GPM, use Hunter SJ-712 with additional top and bottom ¾-inch Marlex street ells. For flow exceeding 6 GPM and/or for systems with less than 50 psi operating pressure, use Lasco 3/4" Four Elbow Swivel Joints, T7-412, with additional 3/4" Marlex street ells on the inlet and outlet.
c. 1-inch inlet sprinklers: Lasco 1-inch Four Elbow Swivel Joints, T9-412, with additional 1-inch Marlex street ells on the inlet and outlet, or Lasco G132-212, or approved substitution, with additional top and bottom 1-inch Marlex street ells
d. Quick couplers: Dura 1-A4-1-11-18 swing joint with DL-010 quick lock, or approved substitution

20. Drip Irrigation

    a. Drip Zones: Use RainBird PEB Series valves with RainBird in-line pressure regulators sized for zone GPM and pressure requirements of 40 psi. Minimum design zone flow to be 0.5 GPM.
    b. Drip Zone Filters: Amiad with 155 mesh (100 micron) filter, or approved substitution, correctly sized to support zone flow/GPM. For multiple valves requiring drip filters, use a primary filter on the irrigation header assembly sized for to accommodate maximum system flow (largest zone at maximum pressure plus a quick coupler valve operating simultaneously at 20GPM), with approval. For example, Amiad steel filters for interior installations (i.e. 2-inch, 120 mesh/130 micron screen rated for 150 psi with steel housing, product number 2-200-1150-1013) or plastic filters for exterior installations (i.e. 2-inch T-S). Set horizontally installed filter at a 45 degree angle to the side and situate the valve box sideways and provide extensions as necessary to provide for filter serviceability.
    c. Drip Line: Toro DL-2000 RGP pressure regulating series drip line, no exceptions; (For blank tube/no emitters) use RainBird 1/2-inch solid tubing; solid tubing can be used as header/supply line in conjunction with 5/8-inch dripline or microline.
    d. Air Relief Valve: AVP-1 air vent in 6-inch round enclosure. Provide air relief valves to reduce soil ingestion. As a general application, install to avoid air locks.
    e. Flush Valve: Toro FCH-H auto flush in 6-inch round RainBird SEB-6X enclosure
    f. Check valves: Use Hunter HC-50F-50F as required to reduce and/or equally distribute low line drainage.
    g. In-line PRVs: use RainBird, rated 40 psi; size per zone flow.
    h. Fittings: RainBird Easy Fit compression Fitting System

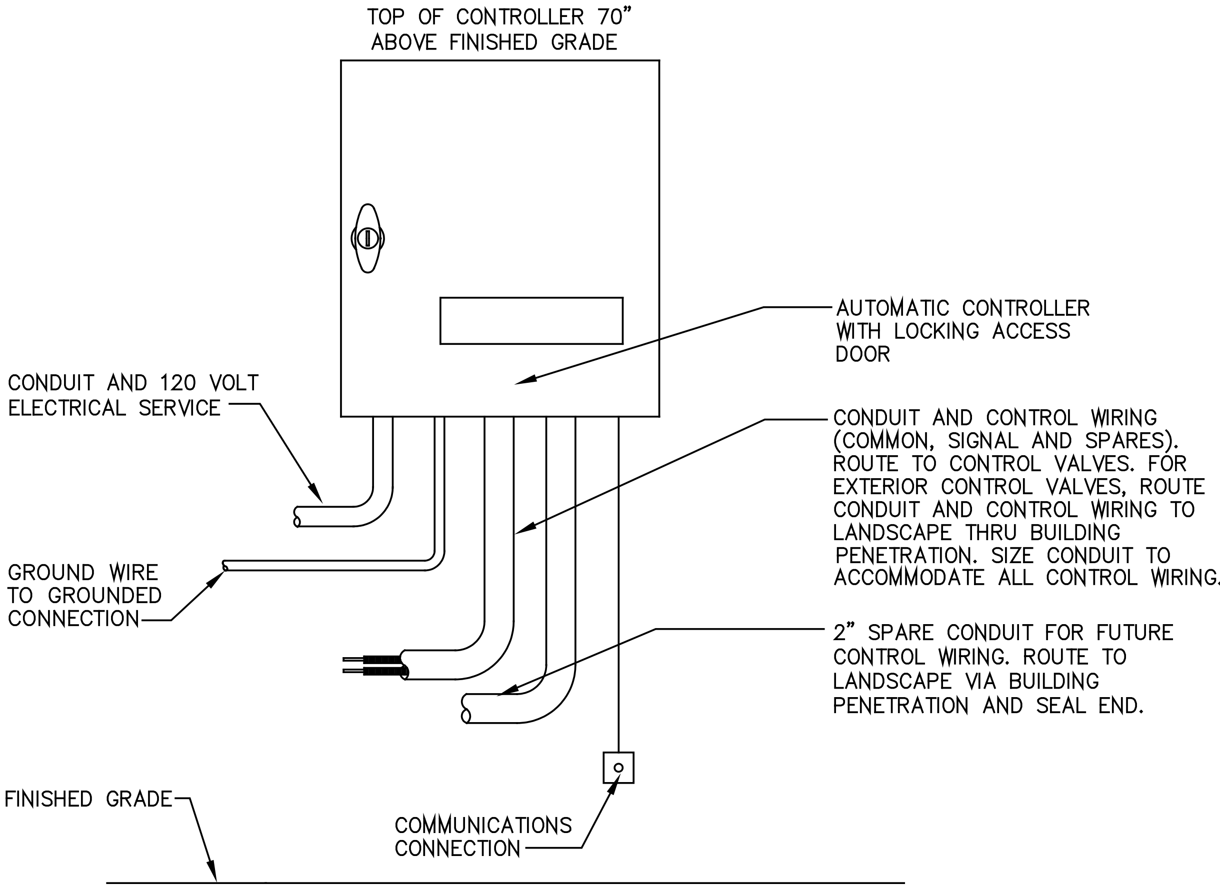
21. Quick coupler valves: two-piece, rubber cover: Buckner QB44RC-10
22. Quick coupler keys: Buckner or Rainbird (44K) with 1-inch FIPT by 1-inch FIPT metal ball valve downstream of key, and a 1-inch FIPT by ¾-inch male hose thread hose swivel (SH-1), connected by a galvanized 2-inch nipple
23. Control wire: Insulated single strand type UF No. 14 copper designated for 20 to 50 volts, UL approved as Type U.F. (underground feeder) with no exceptions. Color code as follows: ground/common wire – white; lead-in signal wire – red; spare signal wire – orange; moisture sensor wire – green; master valve wire – yellow; master valve dedicated common wire – white; future expansion signal spares – black; future expansion common – white.

24. Shielded cable for flow sensor: RainMaster EV-CAB-SEN 2-conductor direct burial shielded copper wire, or Houston Wire D1501802, or approved substitution (direct bury, shielded, 2-18 gauge copper wires, with drain wire)
25. Splice kits: 3M-DB Series, sized for wire size & quantity per manufacturer's recommendations, i.e. DBY, DBR, or approved substitution
26. Drain valves: Buckner No. 72-2 inch or approved substitution. Do not use on irrigation zones unless piping is greater or equal to 3-inches. Use at irrigation P.O.C

Installation, Fabrication and Construction

1. Trenching: Provide minimum 12-inch soil cover (not including mulch) for lateral lines with minimum 18-inch soil cover (not including mulch) for sprinkler mains and quick coupling lines; and minimum 24-inch soil cover (not including mulch) between the main water line and double check valve assembly.
2. Trenching: Install piping side-by-side, to be separated by 2 inches of clean fill. Stacking of piping is not permitted.
3. All zones and mainlines shall independent dedicated trace wire. Secure 14-gauge trace wire to all irrigation piping at 10-foot intervals. Solder tracing wire to all lateral irrigation piping. Do not cut and splice main trace wires to control valves.
4. Sleeve all irrigation piping and control wires installed below pavement. Provide piping sleeves 1.5 times the diameter of the irrigation piping.
5. No bending of pipe. Use fittings for directional changes.
6. Construct all plastic-to-metal joints with plastic male adapters.
7. Provide 4-inch thick concrete base for all pedestal-mounted controllers. 'Quick Pad' valve box mounting may be used with approval only.
8. Provide schedule 80 PVC piping, upstream and downstream of the flow sensor per manufacturer specifications (10 pipe diameters upstream and 5 pipe diameters downstream from flow sensor, straight pipe, no fittings) when using PVC tee mounted flow sensors; for exterior points of connection only.
9. Tape control wiring at 10-foot intervals and lay adjacent to irrigation mainline piping. Provide a minimum 3-foot coil of wiring at each valve box.
10. Do not splice lead control wiring between control valves and controllers. Separate lead or "hot" wire to each control valve. Common ground wiring is acceptable. Locate all wiring splices in valve boxes. Provide redundant control wiring to remote control valves.
11. Provide all valve access boxes with size extensions to bring valve boxes to finish grade.
12. Do not backfill piping or fittings until inspected and pressure tested. Mainlines to control valves shall be hydraulically pressure tested at 125 psi for 15 minutes, and have 0 psi pressure drop during the 15 minute test period. Test lateral lines at 80 psi for 15 minutes, with no more than 5 psi pressure drop during the 15 minute test period. Perform all hydraulic pressure testing in the presence of a University representative.
13. Mount an 11x17 color coded laminated zone control map adjacent to the controller, showing the location of main valves, numbered zone valves, associated color coded laterals, and a listing of zone numbers & descriptions, i.e. turf, west side of building

14. The Contractor shall meet with the UW Irrigation representative, the Utility Engineer and UW Grounds Maintenance Manager to review/evaluate final irrigation system installation prior to final acceptance.
15. Refer to the following drawings:
    a. Interior Irrigation Controller Wall Mounted
    b. Exterior Pedestal Mounted Controller
    c. Exterior Irrigation Controller Wall Mounted
    d. Irrigation Point of Connection Assembly
    e. Quick Coupler Anchor Assembly and Installation
    f. Exterior Single Zone Valve Assembly
    g. Pop-Up Sprinkler Assembly and Installation
    h. Pop-Up Head Set-Back and Location
    i. Exterior Dedicated Drip Filter & PRV Assembly
    j. ½" Air/Vacuum Relief Valve for Dripline
    k. Automatic Flush Valve for Dripline.
    l. Typical Drip Manifold Connections
    m. Dripline Trench
    n. Dripline Check Valve
    o. Dripline Operation Indicator
    p. Tree Bubbler Detail



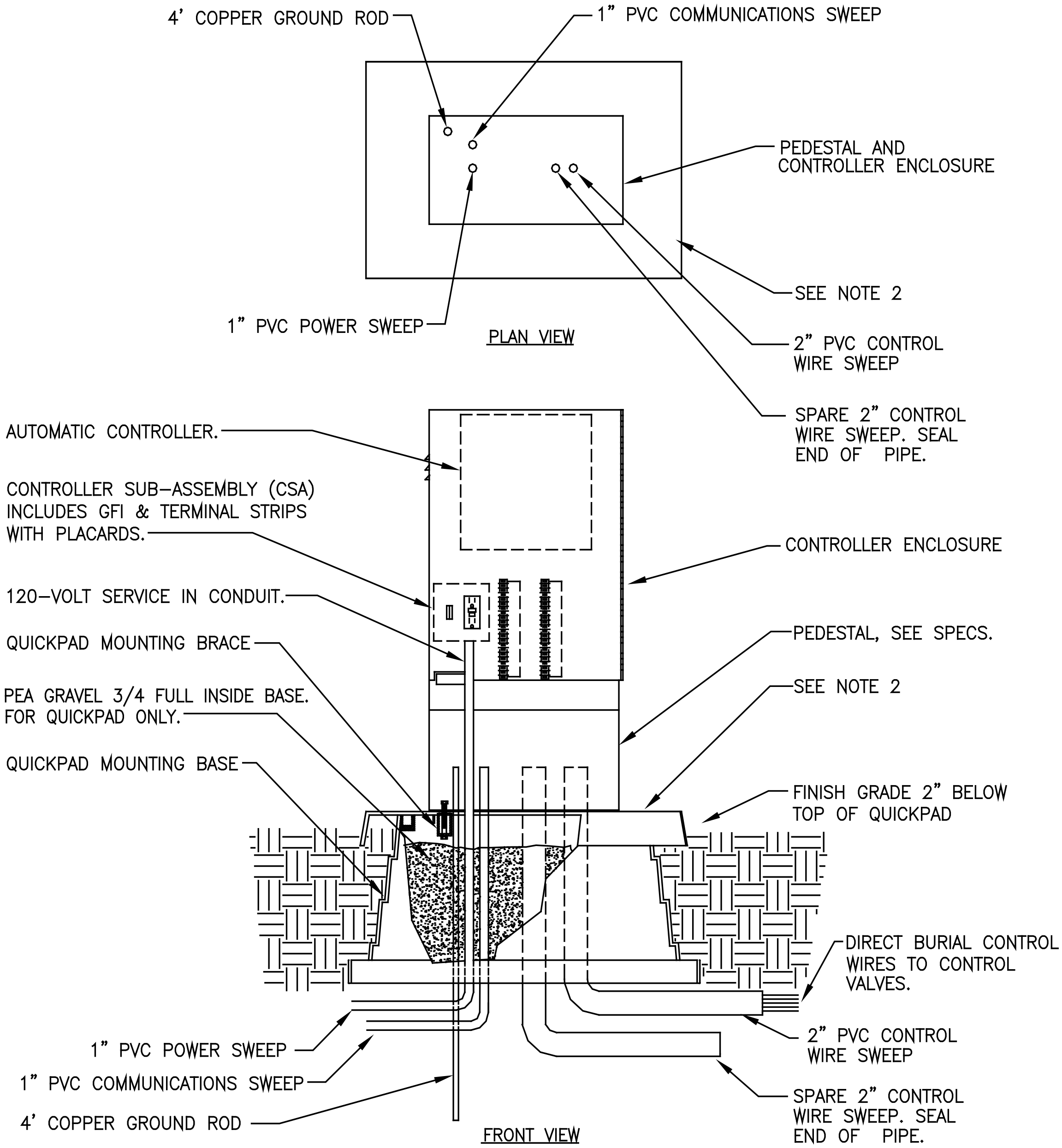
NOTES:

1. ALL WIRES TO BE INSTALLED AS PER LOCAL CODE.
2. VERIFY LOCATION PRIOR TO INSTALLATION.
3. INSTALL CONTROLLER PER MANUFACTURER'S INSTRUCTIONS.
4. PROVIDE COMMUNICATIONS CONNECTION AND JACK TO CONTROLLER LOCATION.

NOT TO SCALE

SD–CI–30

Interior Irrigation Controller Wall Mounted



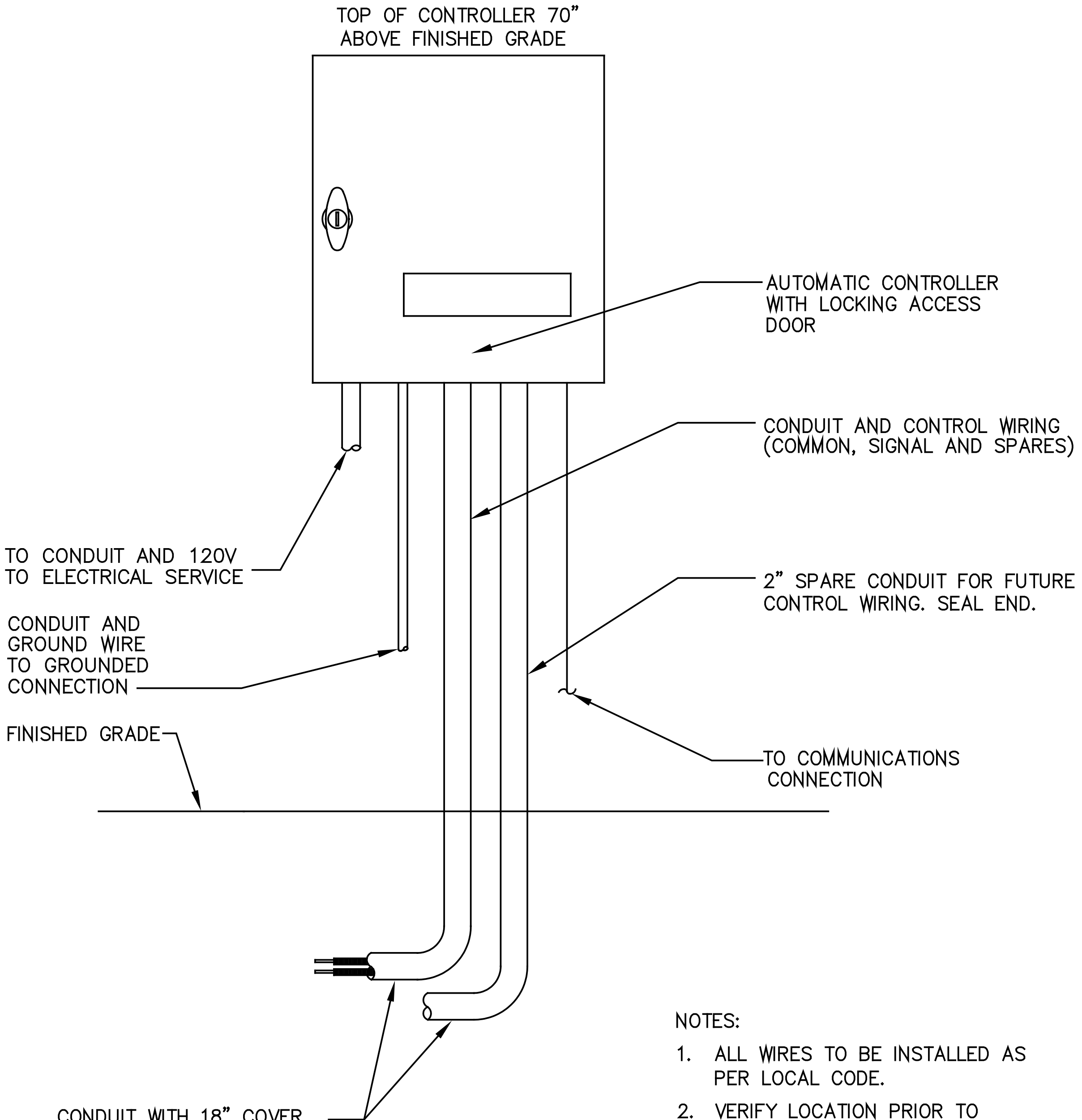
NOTES:

1. FLAG LOCATION FOR APPROVAL BY LANDSCAPE ARCHITECT.
2. QUICKPAD – 3/16" MINIMUM THICKNESS ALUMINUM POWDER COATED PREFORMED PAD FOR STRONGBOX ENCLOSURES, OR CONCRETE BASE PER MANUFACTURER INSTRUCTIONS. SEE SPECS.

NOT TO SCALE

SD-CI-20

Exterior Pedestal Mounted Controller



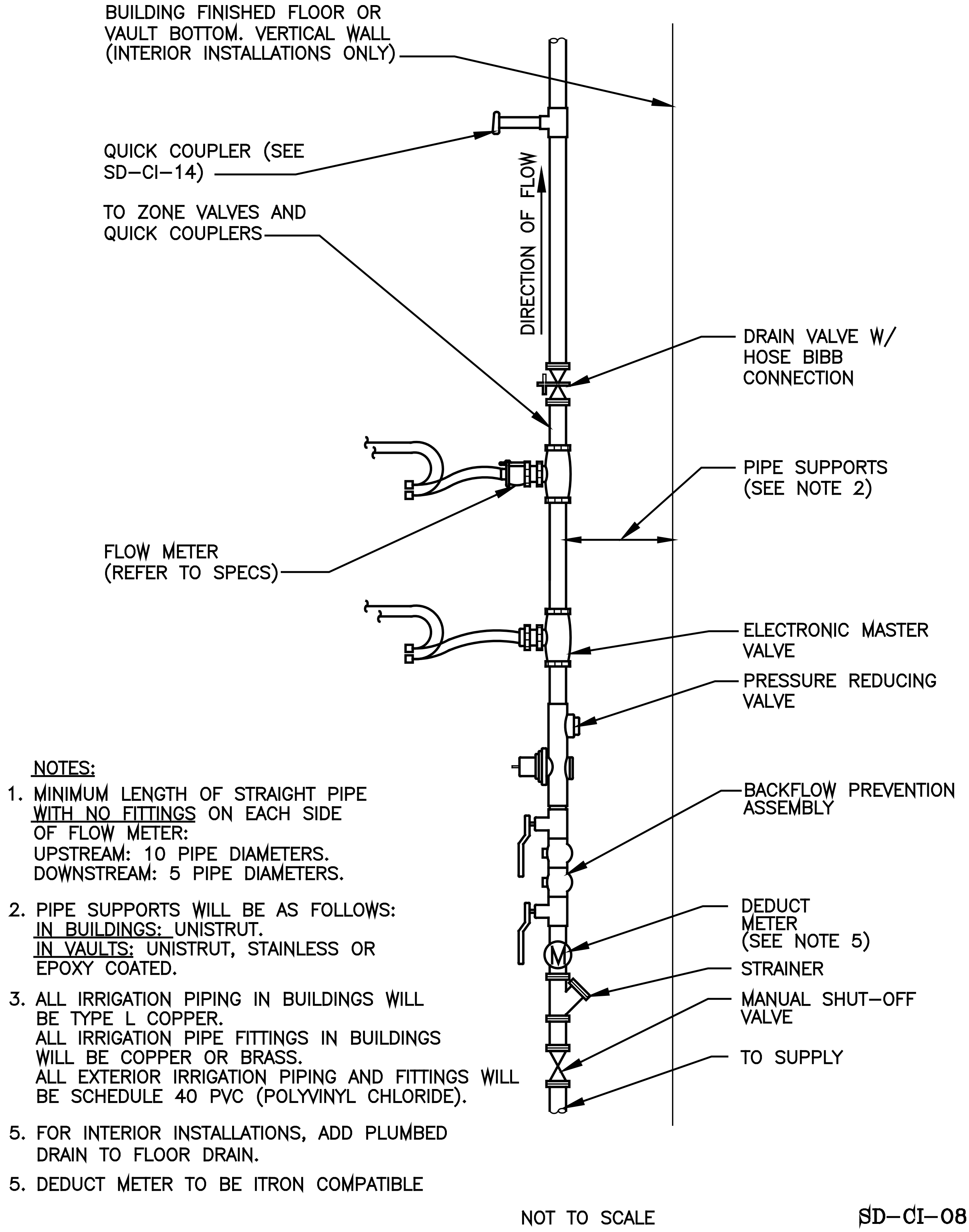
NOTES:

1. ALL WIRES TO BE INSTALLED AS PER LOCAL CODE.
2. VERIFY LOCATION PRIOR TO INSTALLATION.
3. INSTALL CONTROLLER PER MANUFACTURER'S INSTRUCTIONS.
4. PROVIDE COMMUNICATIONS CONNECTION AND JACK TO CONTROLLER LOCATION.

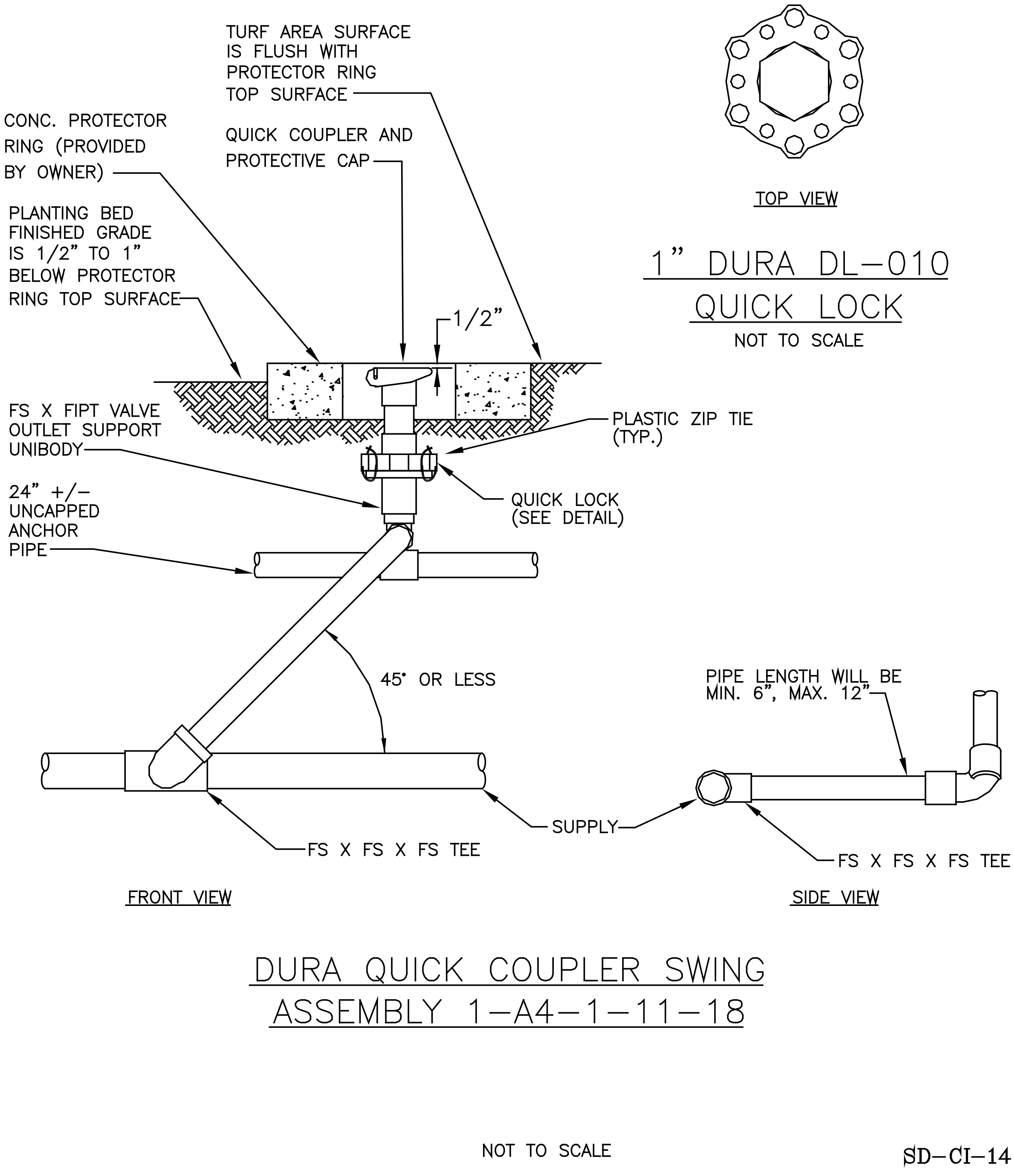
NOT TO SCALE

SD–CI–33

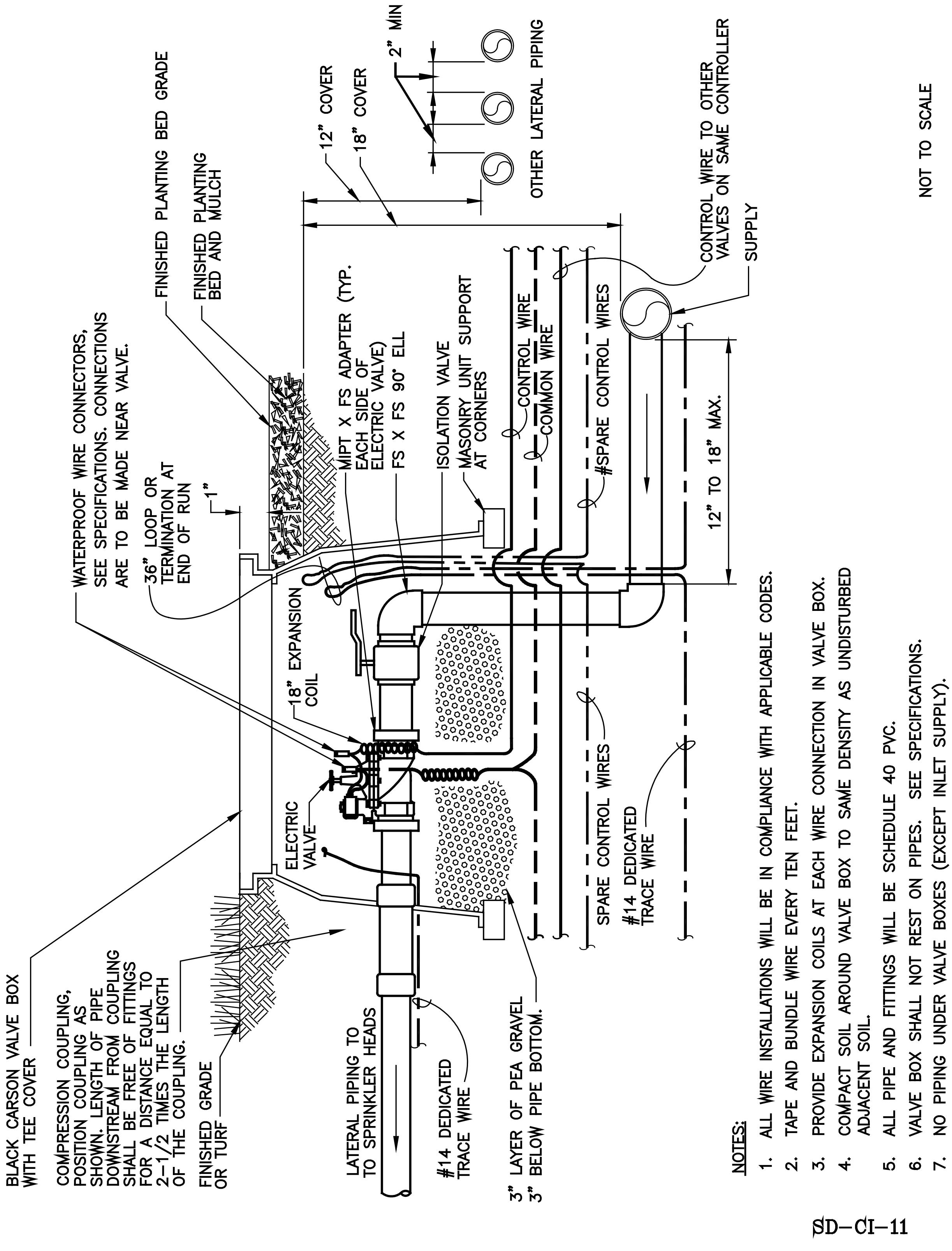
Exterior Irrigation Controller Wall Mounted



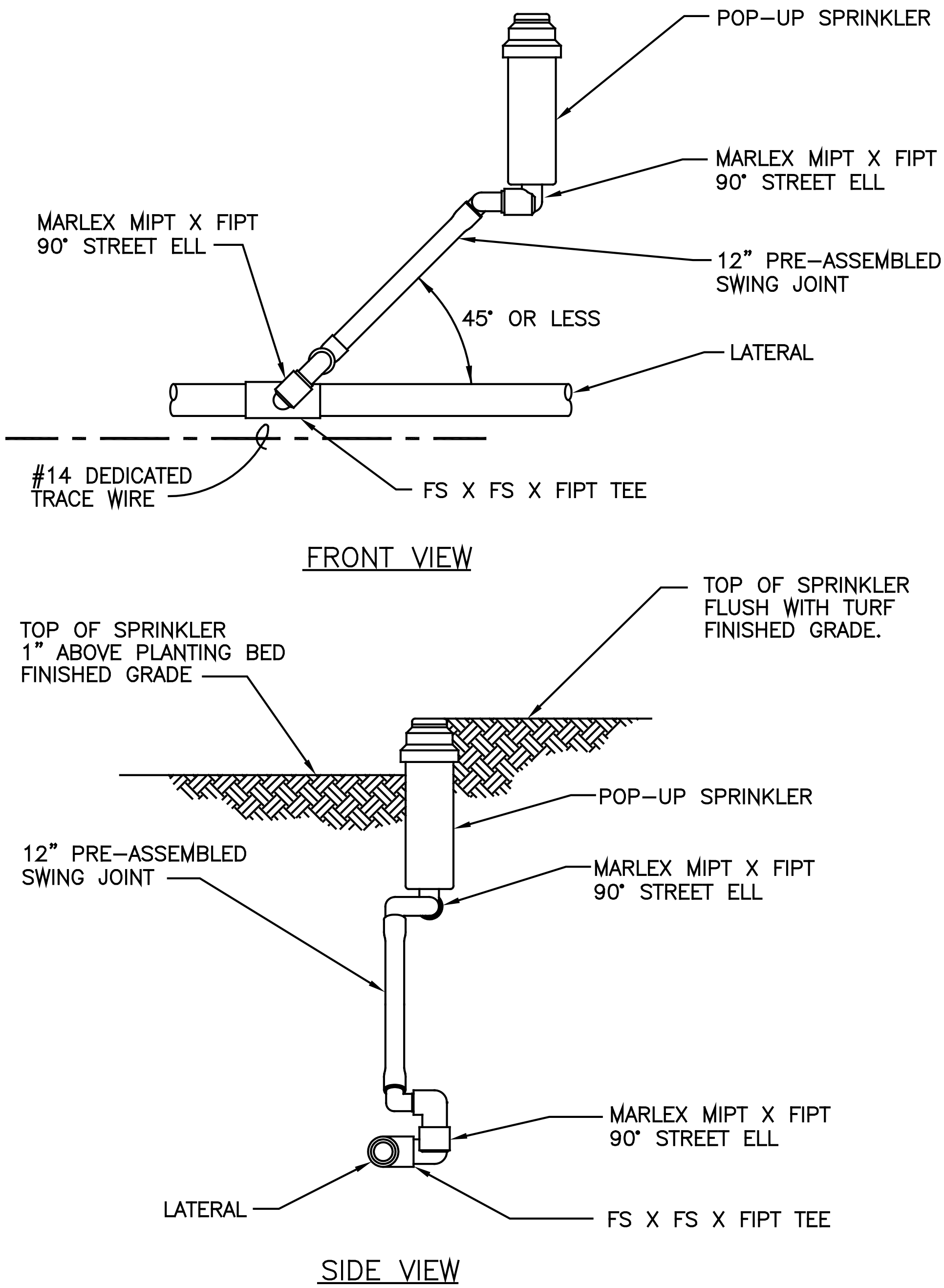
Irrigation Point of Connection Assembly



Quick Coupler Anchor Assembly and Installation



Exterior Single Zone Valve Assembly

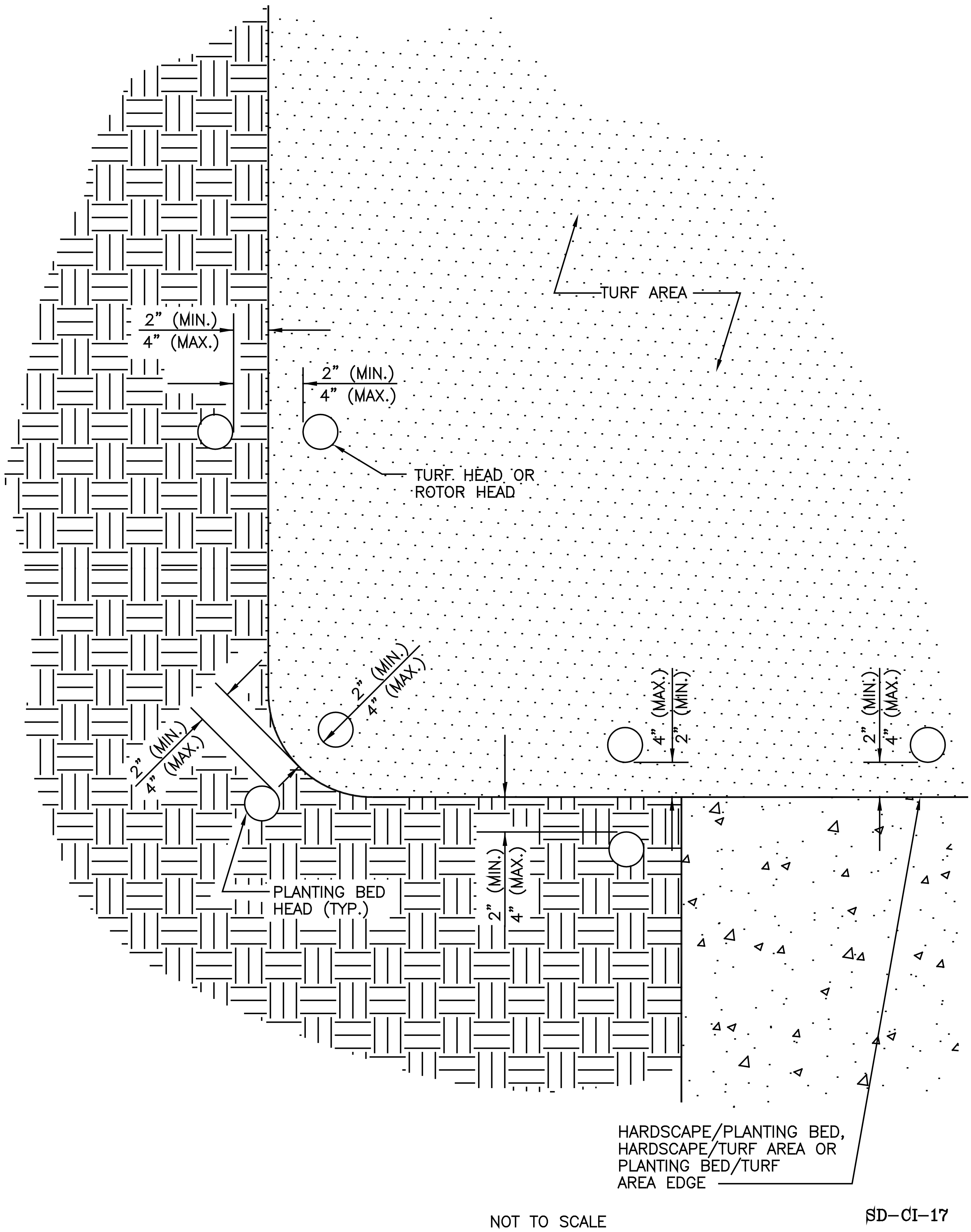


POP-UP SPRINKLER AND PRE-ASSEMBLED SWING JOINT CONNECTION ASSEMBLY

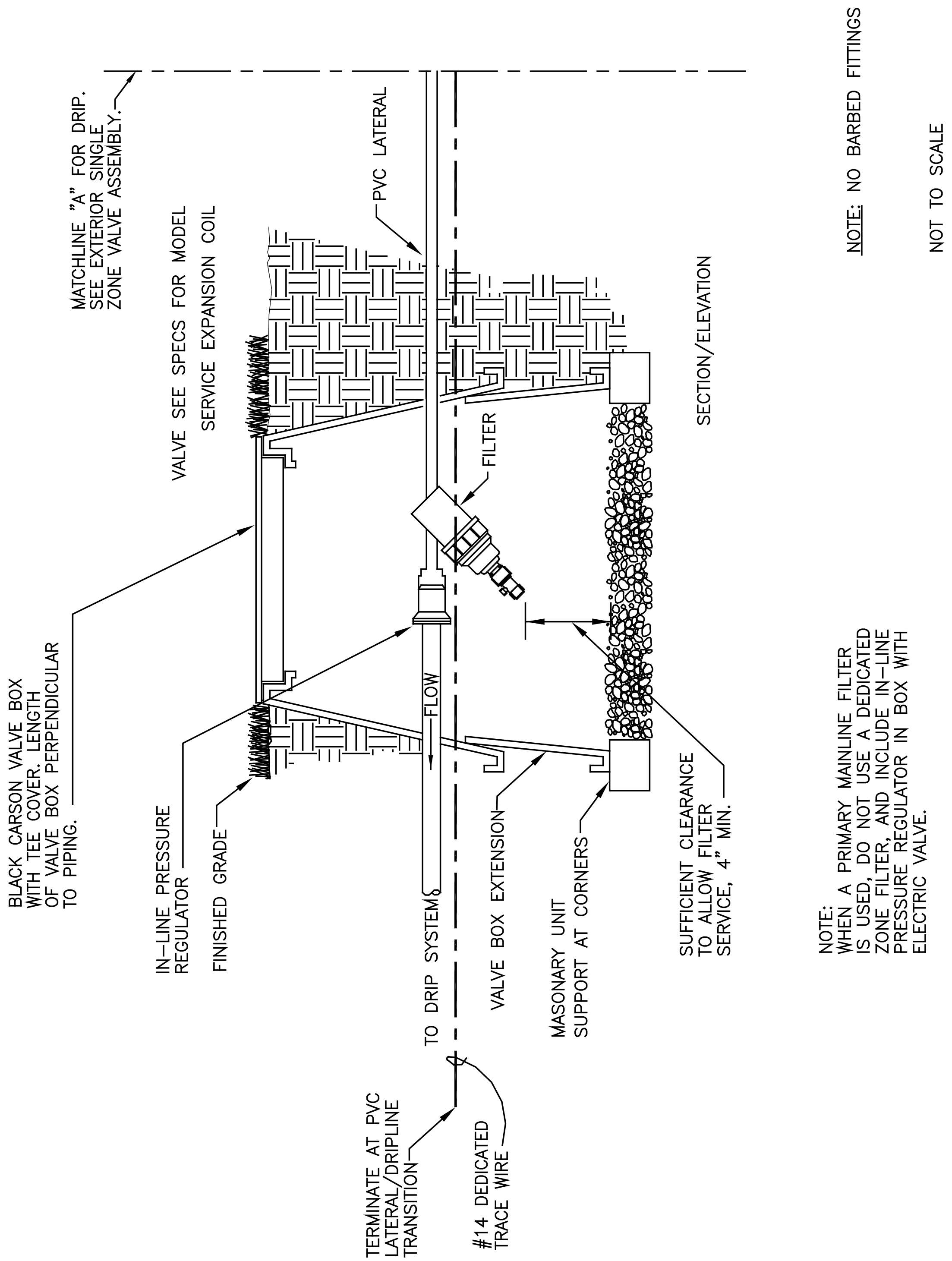
NOT TO SCALE

SD-CI-16

Pop-Up Sprinkler Assembly and Installation

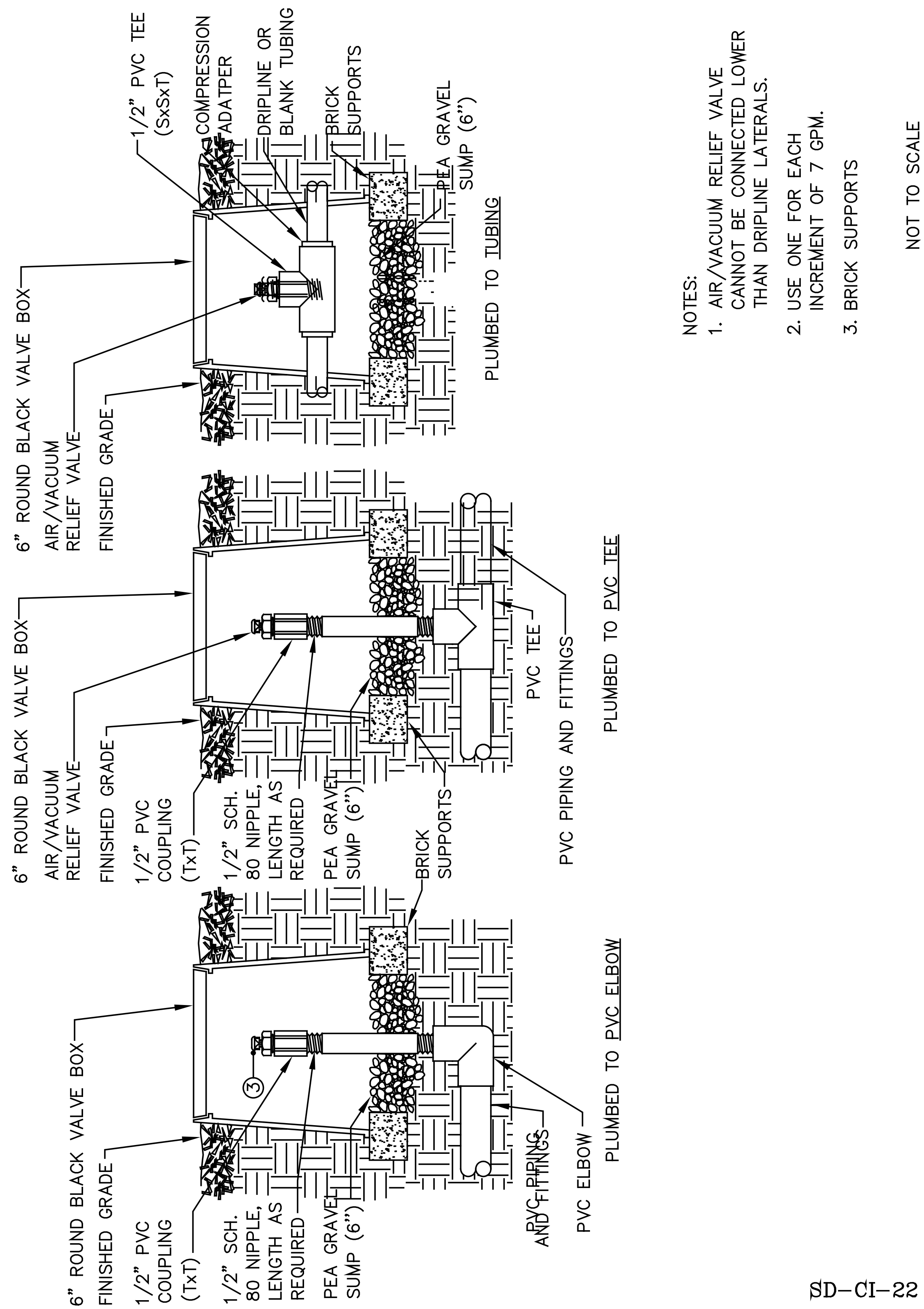


Pop-Up Head Set Back and Location

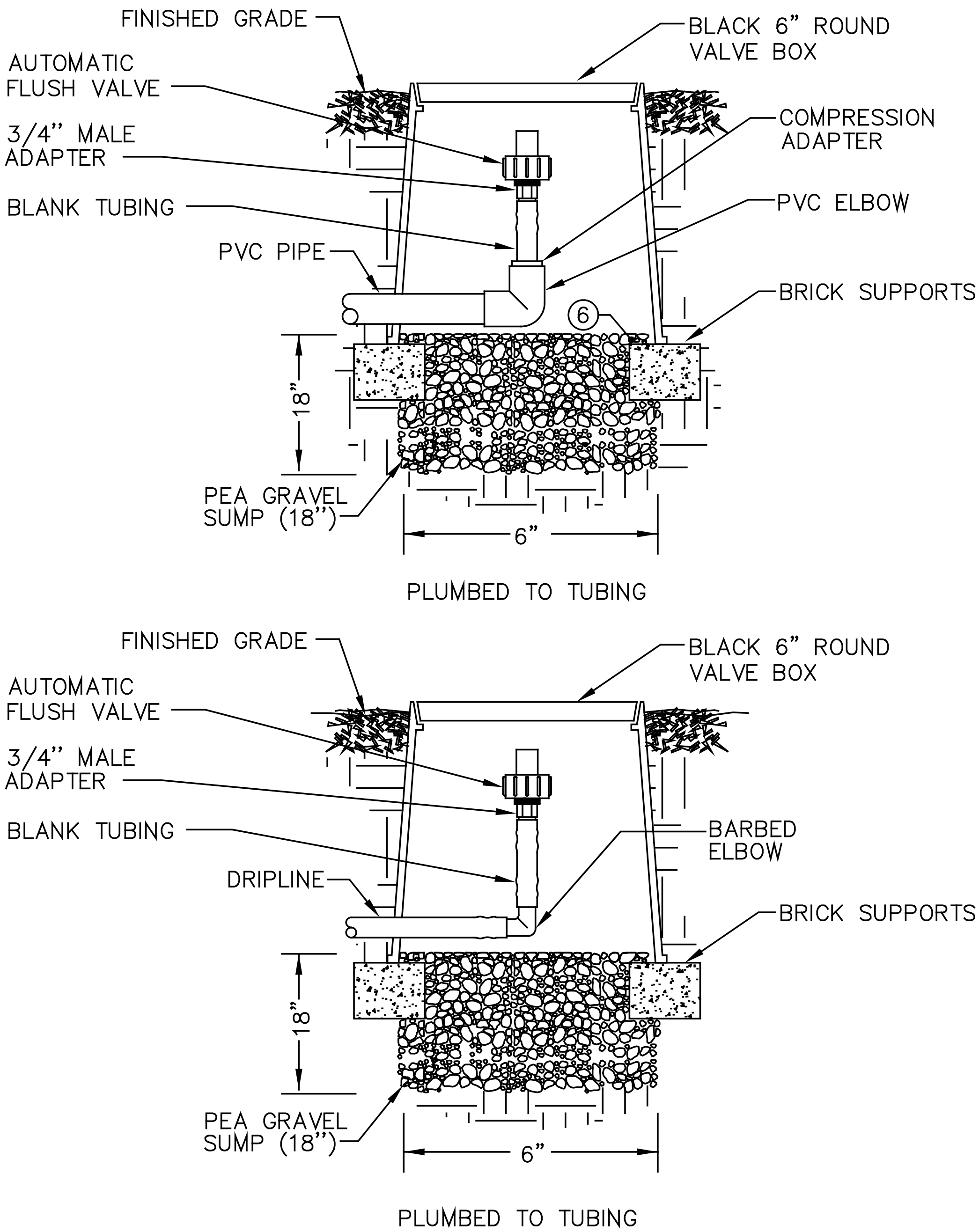


SD–CI–19

Exterior Dedicated Drip Filter and PRV Assembly



½ Air/Vacuum Relief Valve for Dripline

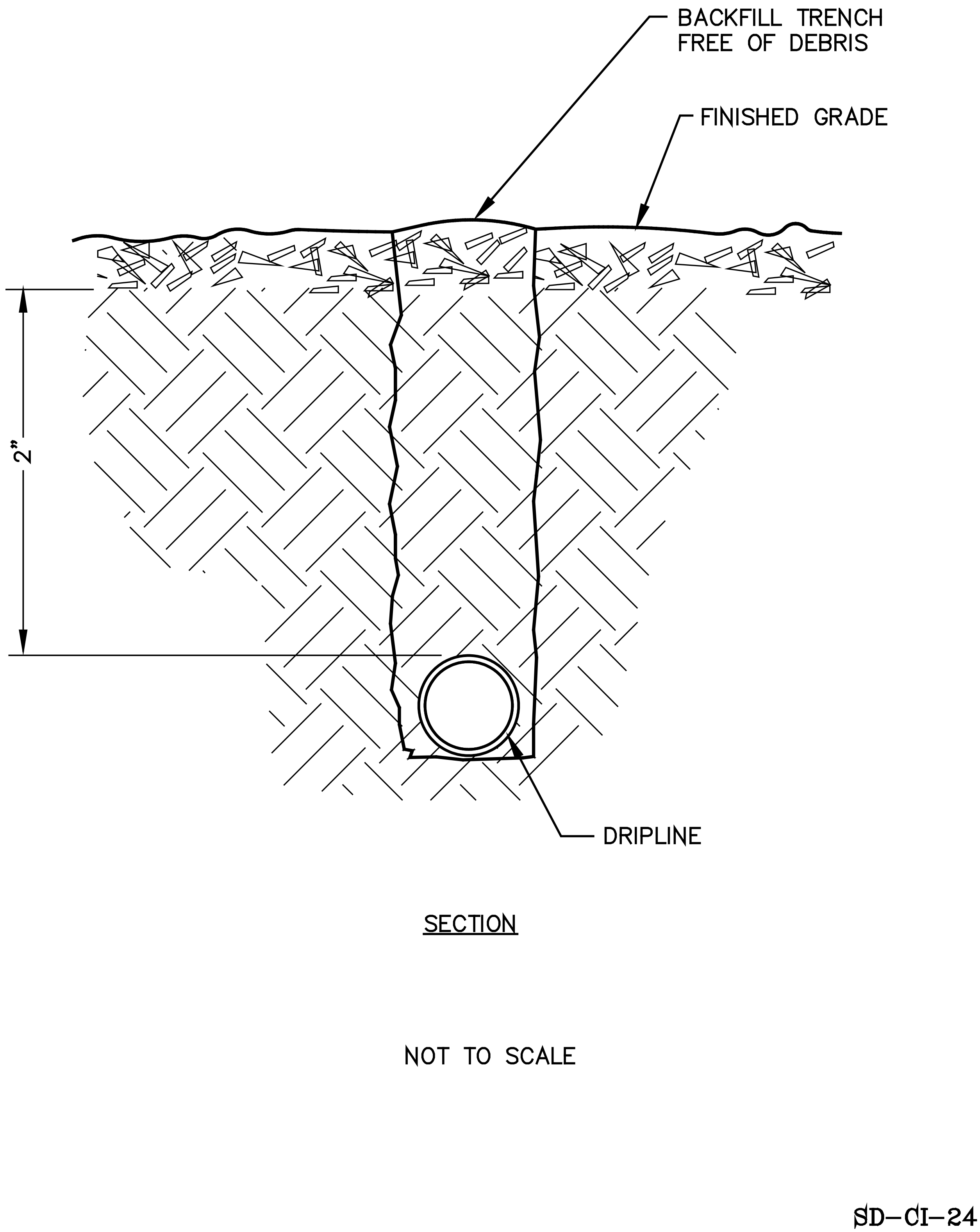


NOTES:
1. USE ONE FOR EACH INCREMENT OF 7 GPM.
2. FLUSH RATE = 0.8 GPM
3. SEALING PRESSURE = 2 PSI

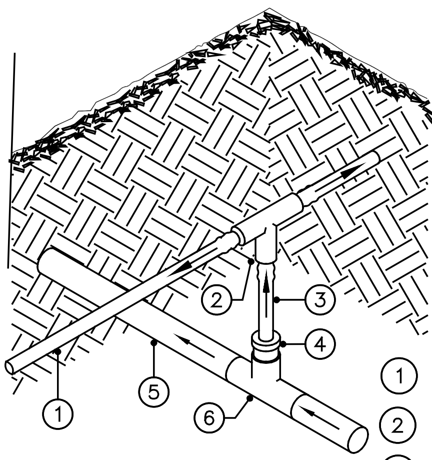
NOT TO SCALE

SD–CI–23

Automatic Flush Valve for Dripline

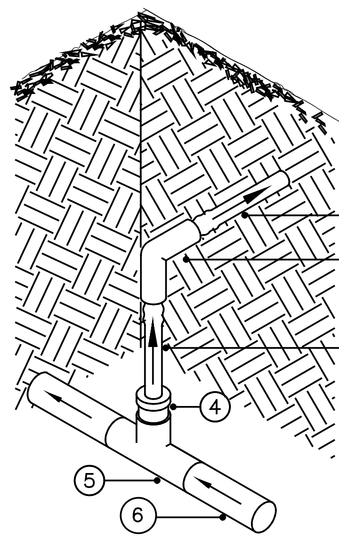


Dripline Trench



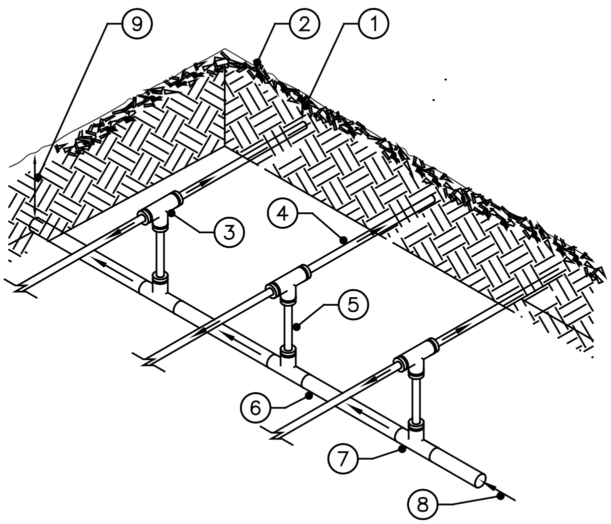
ISOMETRIC
MANIFOLD–TO–TEE
CONNECTION

1. DRIPLINE
2. TEE
3. BLANK TUBING
4. COMPRESSION ADAPTER
5. PVC PIPE
6. PVC TEE (SxSxS)



ISOMETRIC
MANIFOLD–TO–ELBOW
CONNECTION

1. DRIPLINE
2. ELBOW
3. BLANK TUBING
4. COMPRESSION ADAPTER
5. PVC TEE (SxSxS)
6. PVC PIPE



ISOMETRIC
CENTER–FEED SUPPLY MANFOLD

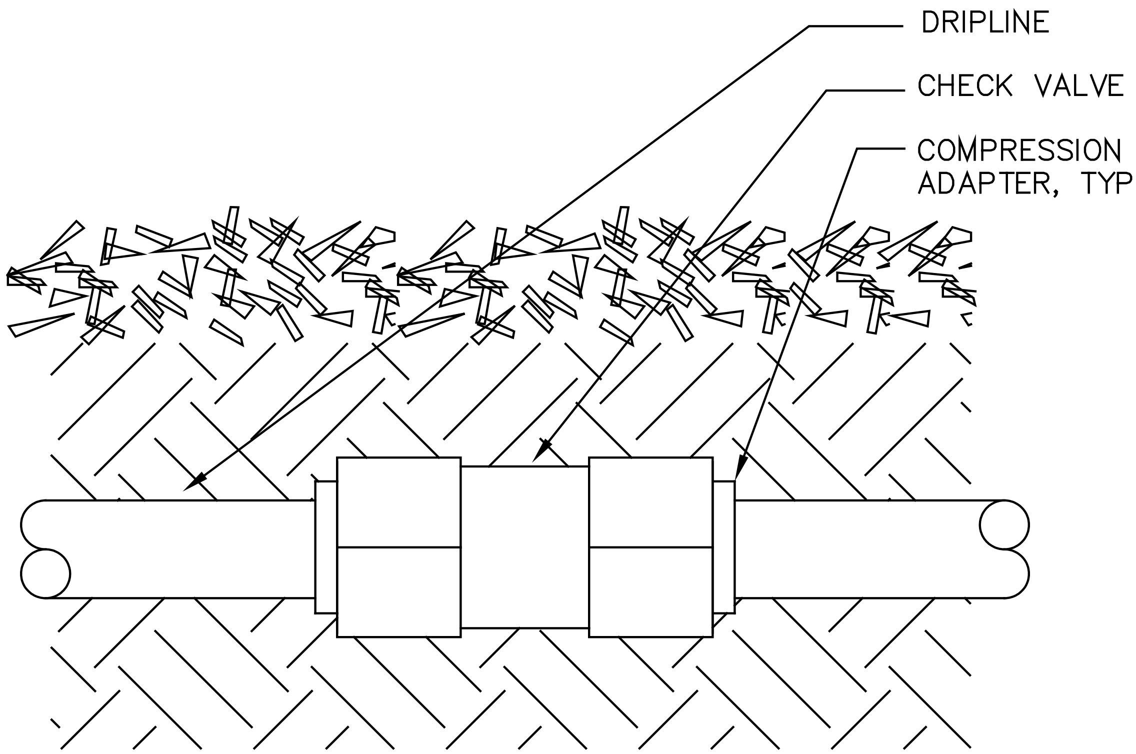
1. 2"
2. FINISHED GRADE
3. TEE, TYP
4. DRIPLINE, TYP
5. BLANK TUBING, TYP
6. PVC SUPPLY MANIFOLD
7. PVC TEE TO COMPRESSION ADAPTERS, TYP
8. FLOW FROM VALVE
9. 12" OF COVER

NOTES:
1. SEE PLANS, LEGEND & SPECS FOR ALL DIMENSIONS AND LATERAL SPACING.
2. RATIO OF LATERALS TO START MAY VARY PER HYDRAULIC DEMAND AT THE START CONNECTION, SEE PLANS & LEGEND.

NOT TO SCALE

SD–CI–25

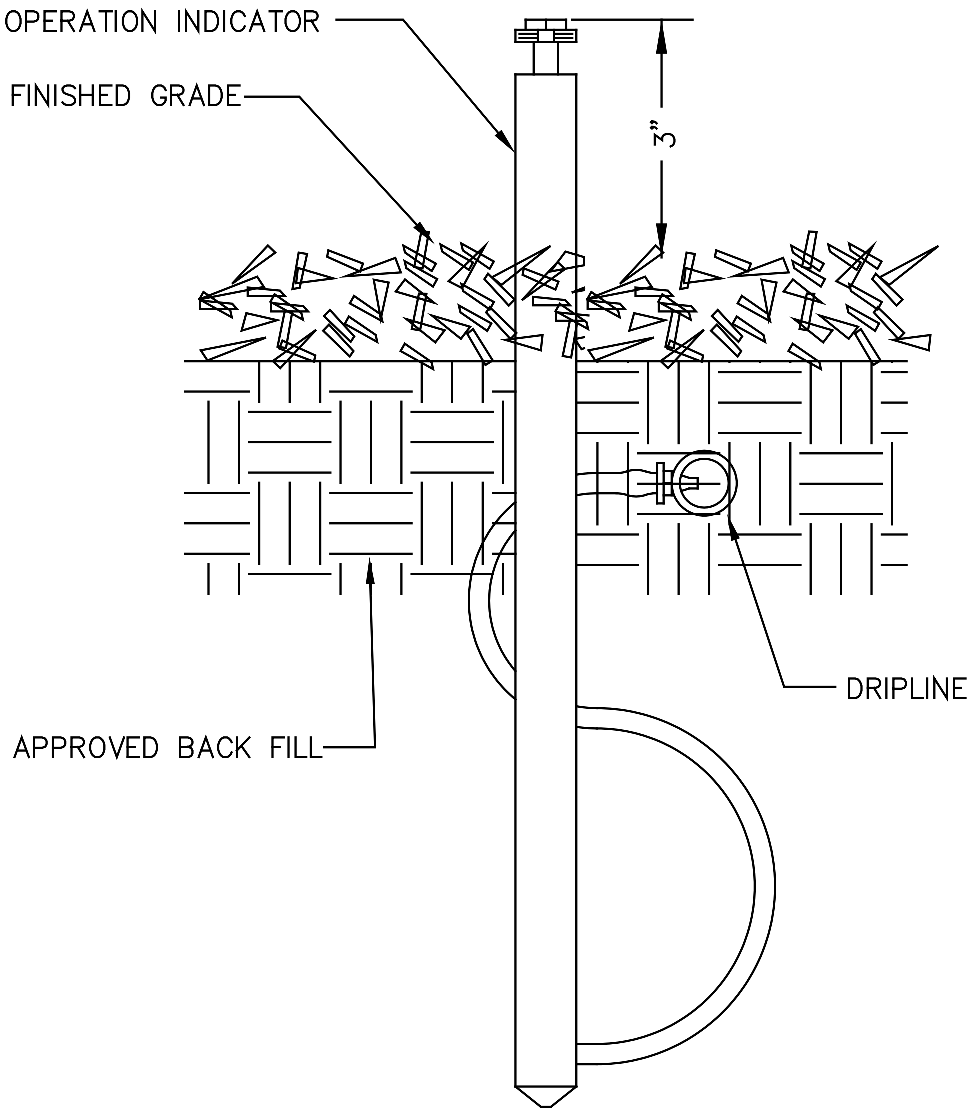
Typical Drip Manifold Connections



NOT TO SCALE

SD–CI–27

Dripline Check Valve



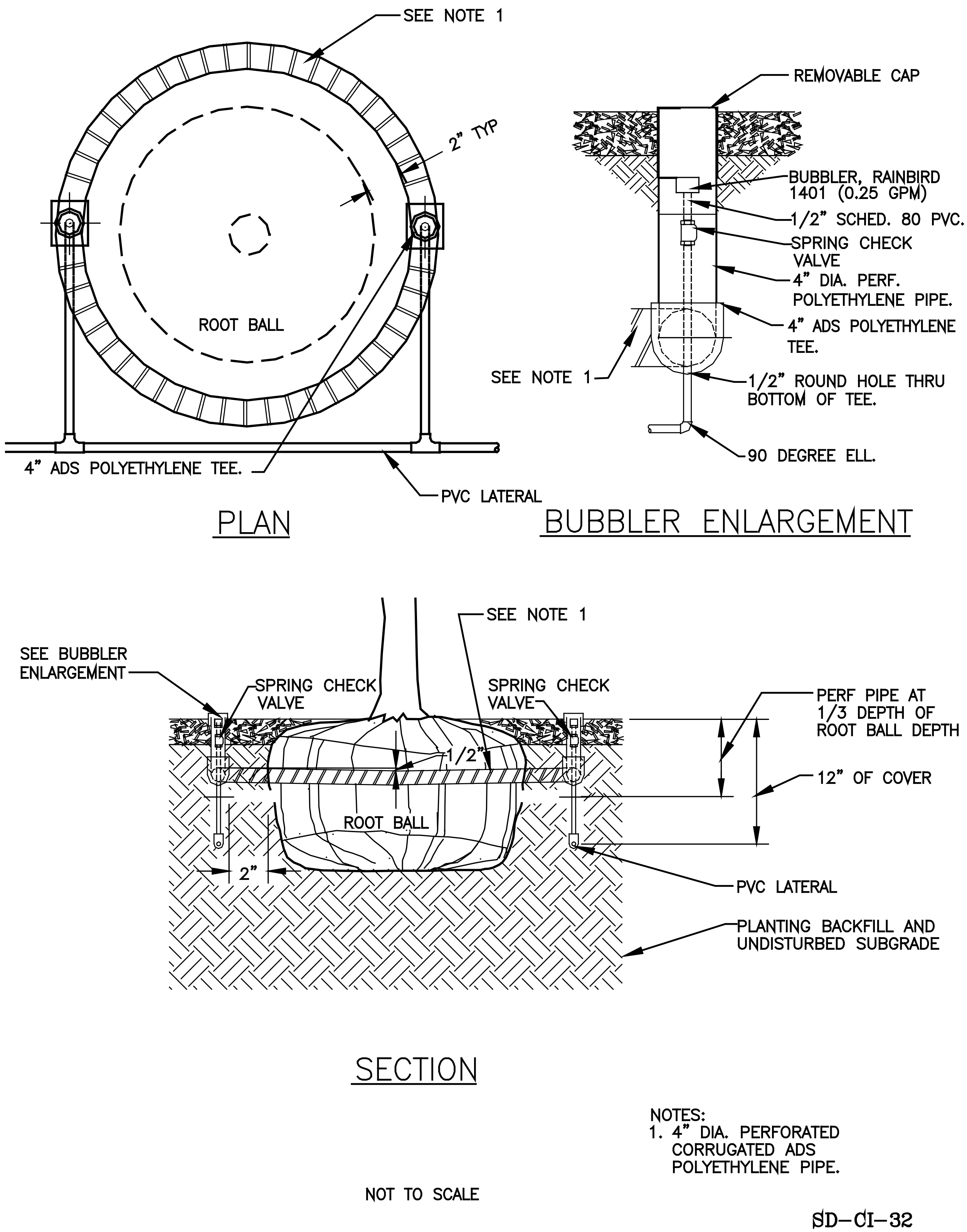
NOTES:

1. USE ONE PER ZONE.
2. PLACE AT FLUSH END OF ZONE.

NOT TO SCALE

SD–CI–28

Dripline Operation Indicator



Tree Bubbler Detail

Exterior Improvements – Miscellaneous

A. Site Furniture

The following are to be used on campus:

1. Contemporary bench with back to be the Neoliviano Bench, 69" length, surface mount as supplied by Landscapeforms. Information found at www.landscapeforms.com.
2. Traditional teak bench with back to be #2604 Parkside Bench 6' as supplied by Gardenside Premium Teak Furniture, San Rafael, CA, 415.455.4500 or www.gardenside.com.
3. Traditional teak backless Bench to be #2316 Westwood Bench 6' as supplied by Gardenside Premium Teak Furniture, San Rafael, CA, 415.455.4500 or www.gardenside.com.
4. Contemporary Ipe backless bench to be the Hudson Bench, 6' surface mount, model number SBHUD-72S as supplied by Forms + Surfaces, Santa Barbara, CA, 800.451.0410 or www.forms-surfaces.com.

B. Bollards

The following bollards are to be used. Bollards shall be made of stainless steel and include the "Viking" cap that contains yellow reflective tape. All are manufactured by Calpipe Security Bollards.

LBMR 6040 – manual retractable bollard

LBMA 8040 – assisted lift bollard

LBMA 8080 – assisted lift bollard

C. Exterior Lighting

Refer to Exterior Landscape Lighting document.

Parking Lots

A. Transportation – Parking Lots

Basis of Design

This section applies to the design of parking lots and other parking areas.

Design Criteria

1. Provide a finish surface for all asphalt concrete paving that is dense, uniform in texture, smooth and free of hollows, depressions, roller marks, and surface cracks.
2. Construct all areas of 3 inches of asphalt concrete paving Class B over 4 inches crushed surfacing top course.

Design Evaluation

The following information is required to evaluate the design:

1. Design Development Phase: Show area of parking lot. Show cross section of pavement section. Provide preliminary specifications for all paving materials.
2. Construction Document Phase: Details, elevations at all edges and breaks, and specifications.

Construction Submittals

1. Asphalt Design Mix
2. Crushed Surfacing Top Course gradation

Related Sections

None

Product, Materials and Equipment

1. The grade of asphalt concrete paving shall be AR-2000 or AR 4000 as specified.
2. Manufacture mineral aggregates for Asphalt Concrete from materials meeting the following test requirements: Los Angles Wear (ASTM Designation C 131) 50 Rev. 30% Max.
3. Crushed Surfacing Top Course shall meet the gradation as shown in the latest WSDOT Standard Specifications.

Installation, Fabrication and Construction

Comply with the following standards in the installation and placement of Asphalt Concrete Paving:

Asphalt Concrete Hauling

1. The Asphalt Concrete mixture shall leave the Mixing Plant at a temperature between 260º F and 350º F and be not less than 250º F when deposited on the roadway.
2. Transport the mixture in suitable dump trucks of sufficient size and shape to easily accommodate the load.
3. When required by the University of Washington, cover each load with a suitable tarpaulin while in transit to prevent spillage and/ or to prevent unnecessary heat loss.

Preparation of Existing Surfaces

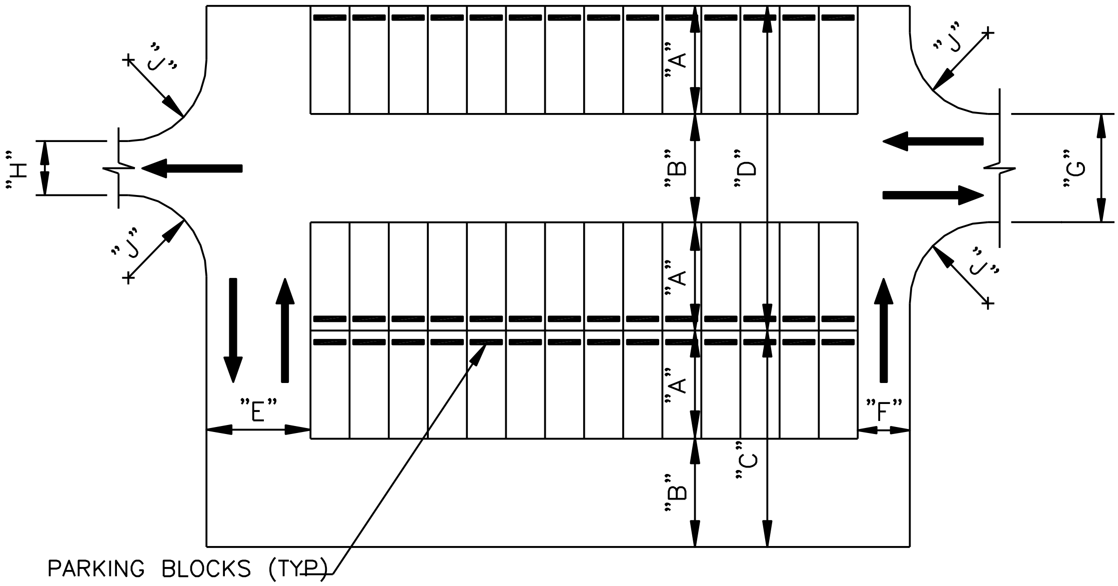
1. Compact Crushed Surfacing Top Course to 95% of optimum density (Modified Proctor)
2. Remove all fatty asphalt patches, grease drippings and other objectionable matter from existing asphalt surfaces.
3. Sweep the existing pavement to remove dust and other foreign matter.
4. Uniformly apply a tack coat of emulsified asphalt at the rate of .02 to .05 gallons per square yard of retained asphalt to all existing surfaces on which any course of asphalt concrete is to be placed.

Preparation of Asphalt Patches

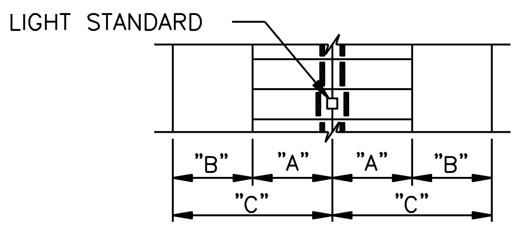
1. Where existing asphalt concrete pavement must be removed and patched, remove all deteriorated asphalt concrete and soft sub-base by making vertical cuts in the asphalt at least 6 inches beyond the deteriorated asphalt concrete.
2. Replace the Crushed Surfacing Top Course to 95% density of its proctor (modified). Apply asphalt concrete a minimum of 3 inches deep.

Miscellaneous Details of Construction

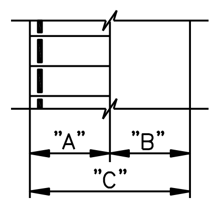
1. Do not proceed with construction of one course or lift upon another until the underlying course is completely cooled and set.
2. Do not deposit asphalt concrete mixture if the rolling cannot be completed before dark.
3. Do not place asphalt concrete in standing water.
4. Where the asphalt concrete is to be placed against concrete or stone curb or gutter, or against a cold pavement joint or any metal surface, apply a thick paint of cutback asphalt in advance of the placing.
5. The finished surface, when tested with a 10-foot straight edge, shall reveal no deviation in excess of ¼ inch.
6. Take core samples, 4 inches in diameter, to verify total asphalt thickness. The Contractor shall patch all the test holes to the satisfaction of the University of Washington.
7. See Parking Area Right Angle Parking drawing.
8. See Typ. Parking Area Spacing drawing.
9. See Precast Parking Block drawing.



PARKING PLAN



DOUBLE ROW



SINGLE ROW

STALL AND AISE DIMENSIONS NOTE 1										
ANGLE	DIRECTION	"A"	"B"	"C"	"D"	"E"	"F"	"G"	"H"	"J"
90°	BACK IN	20'	20'	40'	60'	20'	10'	20'	10'	15'
90°	DRIVE IN	20'	20'	40'	60'	20'	10'	20'	10'	15'

NOTES:

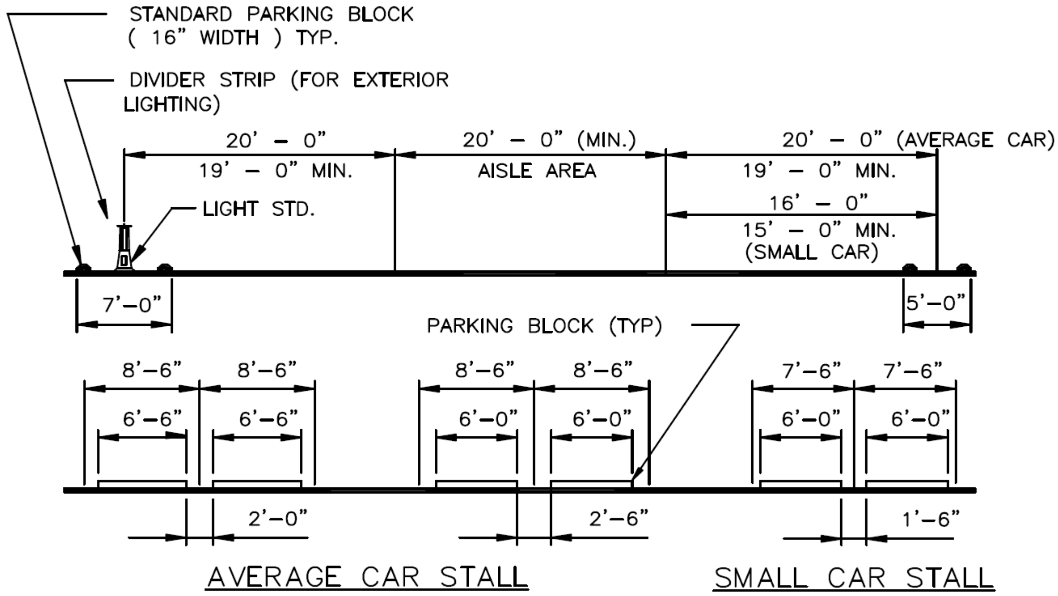
1. DIMENSIONS SHOWN ARE FOR AVERAGE CAR STALLS. SEE SD–C–66 FOR DIMENSIONS OF SMALL CAR STALLS.
2. DIMENSIONS "E" & "G' ARE FOR TWO–WAY TRAFFIC. THESE INCLUDE ALLOWANCE FOR EXTRUDED CURBING ALONG THE PERIMETER.
3. DIMENSIONS "F" & "H' ARE FOR ONE–WAY TRAFFIC AND INCLUDE ALLOWANCE FOR EXTRUDED CURBING ALONG THE PERIMETER.
4. FOR MORE INFORMATION AND NOTES OF RIGHT ANGLE PARKING SEE TYPICAL PARKING AREA SPACING DWG.

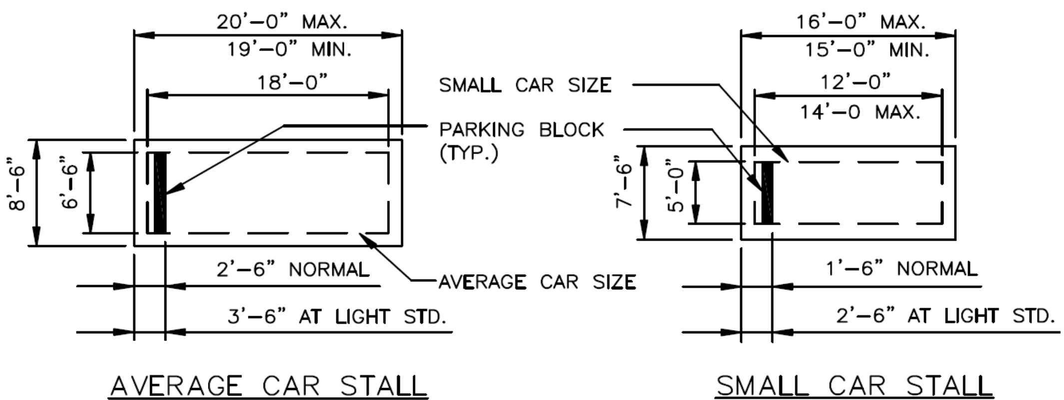
SD–C–65

Parking Area Right Angle Parking

REV:06 – SEPT2017

2M - 03





NOTES:

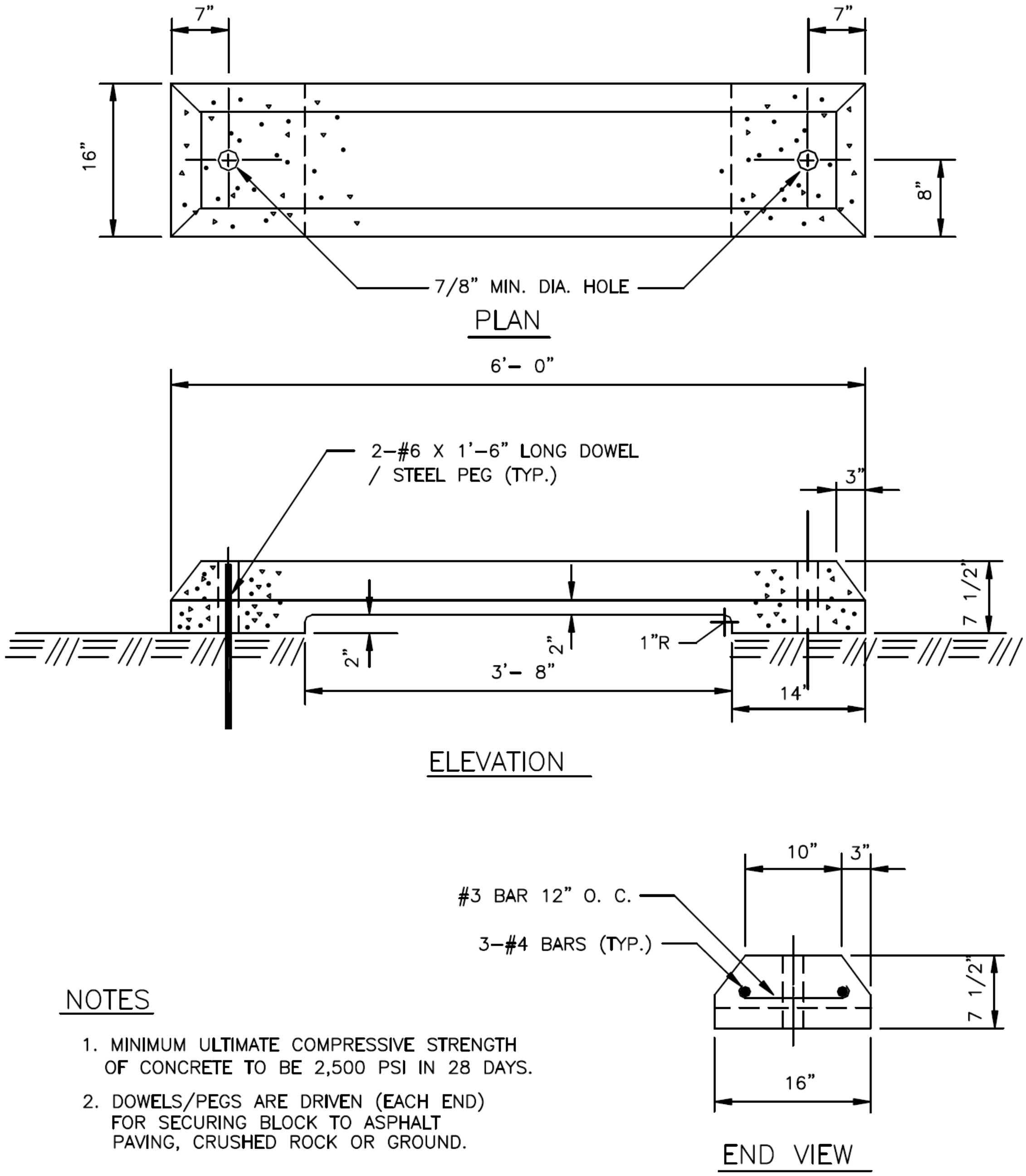
1. BEFORE FINALIZING PLANS FOR PARKING AREAS, CONSULT THE UNIVERSITY LANDSCAPE ARCHITECT FOR PLANTING REQUIREMENTS.
2. THE FINAL DESIGN FOR ALL PARKING AREAS IS SUBJECT TO APPROVAL BY THE UNIVERSITY LANDSCAPE ARCHITECT.
3. FOR MORE INFORMATION AND NOTES SEE RIGHT ANGLE PARKING DRAWING.

SD–C–66

Typical Parking Area Spacing

2M - 04

REV:06 – SEPT2017



NOTES

1. MINIMUM ULTIMATE COMPRESSIVE STRENGTH OF CONCRETE TO BE 2,500 PSI IN 28 DAYS.
2. DOWELS/PEGS ARE DRIVEN (EACH END) FOR SECURING BLOCK TO ASPHALT PAVING, CRUSHED ROCK OR GROUND.

SD–C–54

Precast Parking Block

REV:06 – SEPT2017

2M - 05

B. ADA Standards for Accessible Design

Purpose

The University of Washington strives to ensure that people with disabilities are included and have access to programs, services and activities throughout the institution. This work aligns to the University's vision to educate a diverse student body and its values of integrity, diversity, excellence, collaboration, innovation and respect.

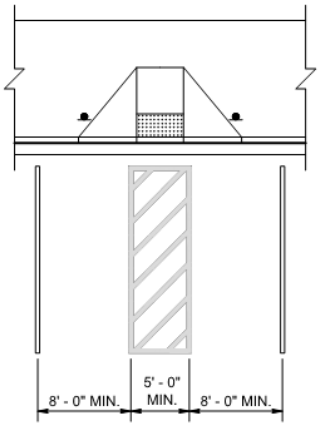
In order to achieve accessibility for students, staff, faculty, and visitors with disabilities across all campuses, the University of Washington expects the built environment to be designed and constructed to meet the 2010 ADA Standards for Accessible Design. In pursuit of this goal, the following section contains common 2010 ADA standards to be followed by designers, contractors, and University staff and faculty. All design and construction work shall comply with all applicable sections of the 2010 ADA Standards for Accessible Design and the full standards document should be sought out for further detail than what is provided in this guideline.

Parking Spaces

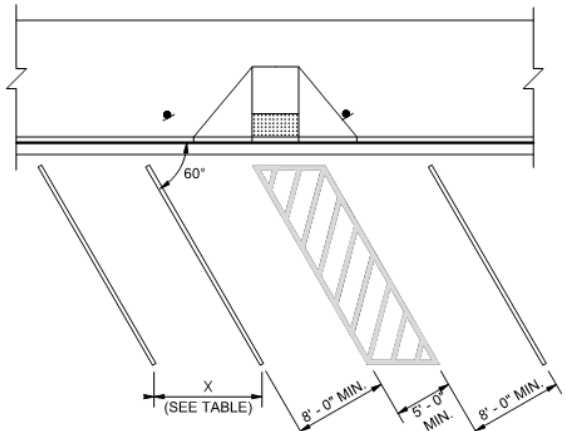
1. ADAS 502.1 - General. Where parking spaces are marked, the width of the parking space shall be measured to the center of the marking.
2. ADAS 502.2 - Vehicle Spaces. Car Parking spaces shall be 96" wide minimum and van parking spaces shall be 132" wide minimum and shall have an adjacent access aisle complying with ADAS Section 502.3. Van parking spaces can be 96" wide minimum if the access aisle is 96" wide minimum. It is UW Transportation Services preference to have all ADA stalls be van accessible to accommodate all vehicles and UW Dial-a-Ride service.
3. ADAS 502.3 - Access Aisle. Access aisle shall adjoin accessible route.
4. ADAS 502.3.1 - Width. Access aisles for car and van parking spaces shall be 60" wide minimum.
5. ADAS 502.3.3 - Marking. Access aisles shall be marked to discourage parking in them.
6. ADAS 502.4 - Floor or Ground Surfaces. Access aisles shall be at the same level as the parking spaces they serve. Slopes in landings shall have a maximum slope of 1:48 (2%). Design to maximum slope of 1.5% (1:66.7).
7. ADAS 502.5 - Vertical Clearance. Parking spaces for vans and access aisles and vehicular routes serving them shall provide a vertical clearance of 98" minimum.
8. ADAS 502.6 - Identification. Signs identifying van parking spaces shall contain the designation "van accessible". Signs shall be 60" minimum above the finish floor or ground surface measured to the bottom of the sign.
9. See Figure below for example accessible stall arrangements for 90° and 60° typical and van accessible stalls.
10. Metered accessible parking spaces shall include curb cuts and sidewalk access to the meter.

Refer to ADAS Section 502 in its entirety for more explicit explanation of the above requirements and for requirements not listed above.

Refer to Guidelines Section 5.2.2 for details on measurement process and tolerances for parking areas.

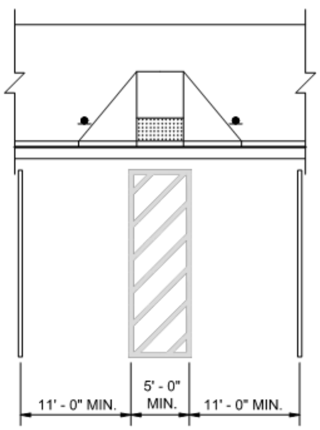


TYPICAL
90° PARKING STALL ARRANGEMENT

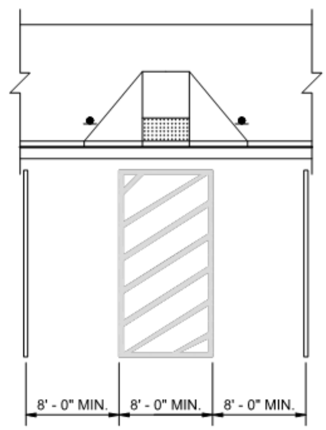


TYPICAL
60° PARKING STALL ARRANGEMENT

STALL WIDTH	X
8' - 0"	9' - 3"
9' - 0"	10' - 5"
10' - 0"	11' - 7"
11' - 0"	12' - 8"
12' - 0"	13' - 10"



VAN ACCESSIBLE
90° PARKING STALL ARRANGEMENT



ALTERNATIVE VAN ACCESSIBLE
90° PARKING STALL ARRANGEMENT

Pavement Markings – Standard Specifications

A. Pavement Markings

PART 1 – GENERAL

1.01 SECTION INCLUDES

A. Preparation for painting pavements and curbs.
B. Painting for street markings such as center lines and crosswalks.
C. Painting parking stalls, marking fire lane, and walkways, symbols, and lettering.

1.02 REFERENCE STANDARDS

A. Seattle Standard Specifications – City of Seattle Standard Specifications for Road, Bridge, and Municipal Construction, 2017.
B. Seattle Standard Plans – City of Seattle Standard Plans for Municipal Construction, 2017.
C. MUTCD – Latest edition of Manual on Uniform Traffic Control Devices for Streets and Highways with latest revisions per WSDOT.

1.03 SUBMITTALS

A. Product Data: Pavement marking materials and colors.

1.04 QUALITY ASSURANCE

A. Pre-Installation Meeting:
   1. Coordinate and attend meeting prior to painting.
   2. Attendees to include paving contractor/installer, Owner, and Engineer.
   3. Agenda:
      a. Owner expectations and installation requirements.
      b. Sequence of Work, schedule, and responsibilities.
      c. Existing pavement conditions and whether hot sprayed thermoplastic is suitable application for a parking lot because of pavement conditions.

1.05 REGULATORY REQUIREMENTS

A. Comply with City of Seattle standards.

1.06 ENVIRONMENTAL REQUIREMENTS

A. Pavement must be clean and dry.
B. Comply with manufacturer's recommendations.

PART 2 – PRODUCTS

2.01 PAINT

A. Streets/Roads, including center lines, edge/fog lines, stop-bars

1. Reflectorized traffic line paint for street striping in accordance with Seattle Standard Specifications Section 9-29. Low VOC (volatile organic compound) solvent-based or waterborne paint.

B. Parking Stalls and ADA Access Aisles - Outdoor:

1. Reflectorized traffic line paint for parking stalls in accordance with Seattle Standard Specifications Section 9-29. Low VOC (volatile organic compound) solvent-based or waterborne paint.

C. Parking Stalls and ADA Access Aisles - Indoor:

1. Non-reflectorized traffic line paint for parking stalls in accordance with Seattle Standard Specifications Section 9-29. Low VOC (volatile organic compound) solvent-based or waterborne paint

D. Crosswalks, Directional Arrows, Pedestrian Pathways, No-Parking Markings, Symbols, Lettering, Parking Stall End Bands, and all other Pavement Markings:

1. Type A – Liquid Hot Applied Thermoplastic in accordance with Seattle Standard Specifications Section 9-29.3(1).

E. Color:

1. Street center lines: Yellow.
2. Fire lane markings: Yellow, Comply with City of Seattle Requirements.
3. All other applications: White.

PART 3 – EXECUTION

3.01 EXAMINATION

A. Verify paving and curbing is complete and surface is ready to receive painting and striping.
B. Verify paving and curbing is sufficiently cured.
C. Verify surfaces to receive painting and striping are dry and free of loose debris.
D. Verify weather forecast during planned time of placement is within weather limitations.
E. For parking lots, verify distance between curbs to ensure adequate width for the indicated number of stalls.
F. For thermoplastic application on existing pavement, assess pavement to verify whether pavement conditions are suitable for hot sprayed thermoplastic.

3.02 PREPARATION

A. Clean and prepare surface for receiving paint in accordance with Seattle Standard Specification Section 8-22.3(2).

1. New pavement:
    a. Ensure pavement is sufficiently cured.
    b. Air blast pavement with a high-pressure system to remove extraneous and loose materials.
2. Existing pavement:
    a. Remove existing pavement markings per Seattle Standard Specification Section 2-02.3(3)J.
    b. Cleaning and removal methods used shall not damage pavement surface. Grinding to remove pavement markings is not allowed.
    c. Air blast pavement with a high-pressure system to remove extraneous and loose materials.

B. Layout lines and symbols to spacing and locations shown on Drawings.
C. Apply primer as recommended by the manufacturer to the area receiving pavement markings.

3.03 CONSTRUCTION

A. Comply with Seattle Standard Specifications Section 8-22.3.
B. Ensure that both the pavement surface and the air temperature during application are not lower than 50 degrees Fahrenheit.
C. Provide preliminary layout for Owner review prior to install permanent pavement markings. Layout parking stalls at locations and extents as shown on Drawings. Make sure dimensions from center line to center line of parking stalls match dimensions as shown on Drawings. Do not install pavement marking without Owner’s review of the layout.
D. Install pavement markings at locations, spacing, size, and extents as shown on Drawings.
E. Apply pavement marking materials to clean and dry surfaces.
F. Apply pavement marking materials in accordance to the material manufacture’s requirements and recommendations.
G. For parallel double lines, place painting material in one pass.
H. Place pavement marking lines parallel and true to line.
I. Ensure line ends square and clean.
J. Ensure the top of pavement marking smooth and uniform.
K. For paint, apply two applications of paint to pavement markings. Ensure the second application of paint squarely on top of the first application. Time period between two paint applications: per Seattle Standard Specifications Section 8-22.3(3)E.
L. Ladder Type Crosswalks: Spread white sharp sand over fresh marking materials at a rate of approximately one pound per twenty square feet.
M. Paint Application Thickness: Per Seattle Standard Specifications Section 8-22.3(3)F.

N. Glass Beads Application: For hot sprayed thermoplastic, apply glass beads per Seattle Standard Specifications Section 8-22.3(3) G. Application rate per manufacturer's recommendations.

3.04 TOLERANCES

A. Width of line: Must not be less than the specified line width or greater than the specified line width by 1/4 inch. B. Thickness: 10 percent plus or minus.
B. Thickness: 10 percent plus or minus.
C. Parking stall and ADA path width: 1/4 inch from center line to center line.

3.05 FIELD QUALITY CONTROL

A. Inspection: Owner will observe Work at the following milestones:

1. After completion of surface preparation and before installing preliminary pavement marking layouts.
2. After completion of preliminary pavement marking layouts. Owner will check dimensions of parking stall layouts.
3. After completion of pavement markings.

3.06 PROTECTION

A. Protect painted surfaces until dry.