Facilities Services
Construction Standards
June 2012

OSU Construction Standards

Introduction

The Construction Standards support OSU's policies related to the design and maintenance of facilities on campus and the Campus Master Plan. They identify specific materials, equipment and furnishings that should be utilized in the construction of buildings and outdoor spaces on campus. They also note requirements for project drawings and address sustainability, universal design and environmental best practices and requirements.

The document is organized in standard construction specification institute (CSI) format. The table of contents provides easy identification of the sections covered in the document.

The document is to be used by all A/E and other design and construction professionals under contract to do work at and for OSU. It is also a resource for staff and faculty. Technical Bulletins are considered appendices to the Construction Standards and must be adhered to as well. The pertinent Technical Bulletins are listed below the Construction Standards on the same website.

The standards in the document have been researched and selected by a cross section of staff and professional consultants. They are standards, but are not absolutes. If a more appropriate product, material or practice provides additional value to OSU, it should be considered. Items different from those identified in the Construction Standards will be reviewed by OSU for life cycle cost, environmental impact and future flexibility. Proposed changes should be submitted as early as possible during the design process. Designs must comply with the Construction Standards unless written verification of substitution is provided by OSU.

Please note that OSU's University Housing and Dining Services department has a similar document that directs work within their facilities. For more information you can contact Dan Larson, Associate Director for University Housing & Dining Services at 102 Buxton Hall, by phone at 541-737-0683, and email at dan.larson@oregonstate.edu.

Additionally, OSU's Network Services department has a set of design standards that are applicable to network infrastructure, internet connectivity and phone services. For more information you can contact Gregory S. Edmaiston, Manager of Information Technology Design Services at A012 Kerr Admin Building, by phone at 541-713-3442, and email at greg.edmaiston@oregonstate.edu. All three documents must be adhered to by design and construction professionals under contract to provide services at OSU.

CONSTRUCTION STANDARDS
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Section 00 00 01 OSU ACCESSIBILITY "BEST PRACTICES"

PART 1 – PURPOSE

In the pursuit of becoming a fully accessible campus, Oregon State University expects all Consultants and service providers to design to 2010 ADA Standards for Accessible Design and the Oregon Structural Specialty Code (OSSC) and to exhibit a commitment to employing Universal Design Principles in their service and product delivery. Consultants will engage with project representatives on how Universal Design Principles will enhance campus accessibility that will meet a variety of needs and create a campus that is accessible to everyone. Designers will ensure that the principles of Universal Design are considered to the project representative's satisfaction.

PART 2 – DESIGN PROCESS AND REVIEW REQUIREMENTS

1. Accessibility Considerations and Review in Project Design
    - A. The Accessible University Advisory Committee (AUAC) is charged with developing and overseeing the implementation of a comprehensive plan for improving the accessibility of OSU's built environment. AUTIF shall be consulted if any of the following conditions exist:
        - 01. OSU Accessibility Best Practices cannot be strictly adhered to because of conditions beyond the control of the designer.
        - 02. An element of the project requires further interpretation of the OSU Accessibility Best Practices or further discussion to determine the most appropriate solution.
        - 03. Adhering to the OSU Accessibility Best Practices is in conflict with the requirements of the Historic Review Committee.
        - 04. The designer believes an alternative solution meets or exceeds the functionality of the OSU Accessibility Best Practices.
        - 05. An element of the project will impact accessibility and the OSU Accessibility Best Practices does not address the issue.
2. Accessible Design Workshop
    - A. For all New Construction and Major Renovation projects, design teams (including architect/engineer, consultants, Facilities Services Project Manager and Construction Manager assigned to the project, and project "owner") will engage in an "Accessibility Design Workshop" to identify issues related to the specific project and to explore innovative approaches to accessibility. The following should be discussed:
        - 01. Specific accessibility issues related to the project.
        - 02. Opportunities for innovative solutions to provide a fully accessible facility.
        - 03. How accessibility issues will be addressed and how the innovative solutions discussed above can be integrated into the design.

3. Design Review and Recommendations by AUITF
   A. All new construction and renovation projects shall be presented to AUITF in the form of a "facilitated review" during the final stages of Schematic Design and in the Construction Document stage. The review will be facilitated by the Facilities Services Project Manager (and design professional, at the discretion of the Project Manager) and will include the following:
      01. Incorporation of the requirements of the OSU Accessibility Best Practices.
      02. Compliance with the Oregon Structural Specialty Code, 2010 ADA Standards for Accessible Design, and other applicable codes related to accessibility.
      03. Incorporation of Universal Design principles.
      04. Incorporation of concepts and design solutions resulting from Accessible Design Workshop.
4. Third-Party Review
   B. A third-party accessibility review shall be conducted on all new building construction and major renovation projects. A consultant shall be contracted to provide the following services:
      01. Review drawings and specifications for accessibility at the schematic design phase.
      02. Review drawings and specifications at the construction document phase for accessibility.
      03. After each of the two phases of review, the consultant will provide OSU and the design team with input related to elements depicted on the documents that appear to be out of compliance and provide suggestions on how to improve accessibility.
      04. As a project approaches substantial completion, the consultant shall perform an on-site accessibility evaluation of the project to verify that all accessibility-related elements have been constructed as per the drawings and specifications. Any elements that are non-compliant shall be added to the punchlist of items to be corrected.

PART 3 – DESIGN ELEMENTS

1. All design work shall comply with all applicable sections of the following (or latest upgrades, as applicable):
   A. 2010 ADA Standards for Accessible Design
   B. 2010 Edition of the Oregon Structural Specialty Code (OSSC) (as amended – effective March 1, 2012)
   C. ICC/ANSI A117.1 – 2009 Accessible and Usable Buildings and Facilities (Referenced by OSCC)
   D. Proposed Accessibility Guidelines for Pedestrian Facilities in the Public Right-of-Way
   E. 2011 Oregon Elevator Specialty Code
   F. ASME A17.1 – 2010 Safety Code for Elevators and Escalators

G. ORS 447.233 - Oregon Transportation Commission Standards for Accessible Parking Spaces (April, 2008)

H. ORS 447.220 - It is the purpose of (state law) to make affected buildings, including but not limited to, commercial facilities, public accommodations, private entities, private membership clubs and churches in the state accessible to and usable by persons with disabilities, as provided in the Americans with Disabilities Act, and to make covered multifamily dwellings in the state accessible to and usable by all persons with disabilities, as provided in the Fair Housing Act.

2. References
   A. The Principles of Universal Design – The Center for Accessible Design (NC State University – 1997)
   B. Access for Everyone – Dr. Arvid E Osterberg (Iowa State University - 2010)
   C. Signs and the ABA/ADA – Sharon Toji (2010)
   D. Equal Access: Universal Design of Physical Spaces – Sheryl Burgstahler, Ph.D. (University of Washington – 2009)
   E. Campus Pedestrian Facilities: ADA Assessment and Survey (includes recommended performance standards (p.29-30.)- SZS Consulting Group
3. Alterations to Existing Buildings
   A. All of the accessibility construction standards, contained herein, shall apply to existing buildings undergoing alterations unless technically infeasible.
   B. The technical infeasibility of alterations shall be jointly determined by OSU's Project Manager and the designer in consultation with the Office of Equity and Inclusion. The Office of Equity and Inclusion has final authority in determining "technical infeasibility".
   C. At a minimum, the alterations must include an accessible route connecting all functional areas in the building to nearby accessible parking and pedestrian routes.
   D. At least 25% of the alteration cost must be spent on accessibility improvements. (ADA requires 20%, but OSSC requires 25%)
   E. The accessibility improvements shall be prioritized as follows:
      01. Parking.
      02. Accessible entrance.
      03. Accessible route to the altered area.
      04. At least one accessible restroom for each sex or a single unisex restroom.
      05. Accessible telephones.
      06. Accessible drinking fountains.
      07. Additional accessible elements.
   F. Exceptions: the following types of projects are exempt from the 25% requirement.
      01. Alterations limited solely to window, hardware, operating controls, and signs.
      02. Alterations limited solely to improvements to electrical, mechanical, and/or fire protection systems.

03. The abatement of hazardous materials.
04. Alterations that are accessibility improvement projects.

4. Buildings within the OSU Historic District
   A. All of the accessibility construction standards shall apply to any buildings located within the Oregon State University Historic District undergoing alterations unless technically infeasible. This is in addition to the requirements listed above in the section Alterations to Existing Buildings.
   B. Where compliance would threaten or destroy the historic significance of a building as determined by the City of Corvallis Historic Resources Commission, alternative solutions must be implemented to ensure accessibility.
   C. Alternative solutions shall be provided to the OSU's satisfaction. Decisions on alternative solutions must include and be approved by the Office of Equity and Inclusion.
   D. Where the alteration to existing restrooms would adversely affect the historic significance of a building, at least one fully accessible family or assisted-use toilet room shall be provided.
5. The following design specifications should be incorporated into all new construction. In alteration work, these specifications should be utilized to the greatest extent feasible.
   A. Building Blocks
      01. Floor and Ground Surfaces
         a. Use hard or resilient flooring in high traffic, general university areas such as lobbies, corridors, restrooms, and other common areas along all accessible routes.
         b. Carpet should only be used in areas where it isn't a part of an accessible route or in areas where acoustics is a concern, such as in residence halls.
         c. Where carpet is used, use, only short-pile carpet.
         d. At entrances to buildings, provide recessed walk-off mats that are flush with the adjoining floor surface.
         e. Pavers or stamped concrete should not be used on accessible paths of travel. Pavers may be used in other areas, but must be set in mortar on a concrete slab and have flush joints. Stamped concrete, if used, should not have joints larger than 1/8" wide.
      02. Turning Space
         a. Provide elongated circle minimum turning space (60" x 78"). (ADA allows 60" radius or T-shaped turning area)
         b. Only use 60 radius and T-shaped turning space in alterations where space for the elongated circle is not available.
      03. Floor and Ground Clear Areas
         a. Provide clear floor areas with minimum dimensions of 36" x 54". (ADA allows 30" x 48")
      04. Knee Space

a. Provide 30” minimum knee space under tables and counters, wherever possible. It is acknowledged that this amount of knee space is not available with lavatories due to lavatory bowls and plumbing. (ADA allows 27” minimum.)

05. Reach Ranges

a. Provide all controls for building occupants between 18” and 43” above the floor. (ADA allows 15” to 48” or up to 44” over counters up to 25” deep.)

b. Controls and objects shall be placed at least 18 inches away from inside corners of walls to allow for wheelchair access.

c. Locate outlets and other objects that are normally closer to the floor at a consistent height of 18 inches above the floor measured to the centerline of the outlet or object. (ADA allows outlets to be located as low as 15”.)

B. Exterior Accessible Routes

01. Paths of Travel

a. All projects must consider connections from the project site to accessible parking as well as to accessible routes of travel that connect the building to the rest of campus to ensure that we are creating an integrated campus.

b. Where an accessible route intersects with multiple routes where one or more are not accessible, provide signage directing people to the accessible route.

c. When an accessible route of travel needs to be closed for construction purposes, the designer shall direct the contractor to either provide an alternate accessible route or provide signage that directs people to the nearest accessible route.

d. Minimum walkway width: 60” (ADA minimum is 36”.)

e. Design accessible exterior routes without ramps whenever possible.

f. Whenever possible, locate items such as cleanouts, vault covers, grates, and similar items outside of the path of travel. When these items are located within the path of travel, they shall be flush with the surrounding walk.

g. For exterior routes, choose alternatives to ramps (such as sidewalks and proper grading) to achieve gentler slopes.

h. Maximum running slope: 1:25 (ADA allows up to 1:20.)

i. Note: 1:25 slope cannot always be met due to existing conditions and grades. Grades up to 1:20 are allowable where existing conditions prevent lesser grades.

j. Where design slopes on walks approach 5% due to existing conditions, consider the incorporation of a ramp or ramps to provide reduced slopes along the majority of the route. Ramps

may be preferred over long stretches of walks (over 50') at maximum allowable grade.

k. On accessible routes with slopes greater than 4%, landings shall be provided at least every 50'.

l. Where possible, provide benches or other seating elements at landings.

m. Maximum cross slope: 1.5% (ADA allows 1:48 or just over 2%.) This is to ensure that, with construction tolerances, the resulting slope will be less than 2%.

n. Provide minimum of 12" along edges of walks that are flush with walk or provide edge protection.

02. Exterior Ramps

a. When a ramp is necessary, design the ramp slope between 1:20 and 1:16. Strive for the least amount of slope that is feasible. (ADA allows 1:12 maximum slope for ramps.)

b. Individual sections of ramps shall not be longer than 25' without a level landing.

c. Install handrails at 36" above ramp surface. (ADA allows 34" – 38".) Also, include handrail at 26" in locations used primarily or frequently by children.

d. Avoid curved ramps.

e. Where possible, provide a minimum 60" x 72" area at top, bottom, and intermediate landings.

e. The cross slope of ramps and landings shall be 1.5%. (ADA allows up to 2%.) This is to ensure that, with construction tolerances, the resulting slope will be less than 2%.

f. Provide continuous handrails around the perimeter of intermediate landings.

g. The minimum widths required for all ramps and landings are to be the dimensions between handrails.

h. When using steel pipe or tubing, provide minimum wall thickness of .140".

i. Round handrails are preferred.

03. Exterior Stairs

a. Do not design single stair condition.

b. Ensure that the leading edge of treads contrasts with the rest of the treads to increase visibility and safety where appropriate. Provide contrasting strip on the leading edge of the tread that extends a total of 2" back from the leading edge of each tread.

c. Slope treads of exterior stairs 1.5% slope toward the leading edge of the treads. This is to ensure that, with construction tolerances, the resulting slope will be less than 2%.

d. Install handrails at 36” above nosings. (ADA allows 34” – 38”.) Also, include handrail at 26” in locations used primarily or frequently by children.
e. OSSC requires that there be handrails within 30” of any portion of a stair that is determined to be an egress route. On exterior stairs that are not part of an egress route, provide intermediate handrail(s) evenly spaced in increments not exceeding 8’.
f. Provide continuous handrails around the perimeter of intermediate landings.
g. When using steel pipe or tubing, provide minimum wall thickness of .140”.
h. Round handrails are preferred.
i. Provide horizontal handrail extension providing the extension does not protrude into an accessible route.

C. General Site Elements

01. Parking

a. See Oregon Transportation Commission’s *(OTC) Standards for Accessible Parking Places.* The following shall be supplemental to the OTC standards. Where conflicts exist, the following standards shall prevail.
b. Parking stalls shall be designed to be 9’ wide by 18’-6” deep. (ADA allows 8’ wide stalls.)
c. Standard access aisles shall be a minimum of 6’ wide (ADA allows minimum of 5’.)
d. Access aisles adjacent to van accessible or wheelchair accessible spaces shall be a minimum of 8’ wide (ADA allows 8’ access aisle with 8’ wide parking space or 5’ access aisle with 11’ wide parking space; OSSC requires minimum of 17’ overall.)
e. Both parking spaces and access aisles should be designed with a cross slope of 1.5%. This is to ensure that, with construction tolerances, the resulting slope will be less than 2% and still provide enough slope for drainage.
f. The specifications or drawing notes should clearly state that any accessible parking spaces or access aisle slopes that exceed 2% shall be replaced at the contractor’s expense.
g. All accessible parking spaces and access aisles shall be constructed with concrete to allow for better control of slopes during construction.
h. Parking spaces should be designed to avoid the use of wheel stops, where feasible. Wheel stops can be a tripping hazard. Adjoining walks should be designed to be wide enough so that vehicles overhanging the walk do not impede the accessible route.

i. Curb ramps serving accessible parking spaces shall not receive detectable warning. (The current OTC Standards for Accessible Parking Spaces still show detectable warning.)
j. Accessible routes from parking access aisles should not cross behind vehicles or go into vehicular traffic. In those cases where it is not technically feasible or reasonable to separate access route from vehicular traffic, then the accessible routes shall be clearly marked as accessible pedestrian crossings.
k. Accessible parking signage should not be located within a pedestrian way unless location elsewhere would place the sign too far from the accessible parking space. When it becomes necessary to install an accessible parking sign in a pedestrian way, the bottom of the sign should be at 84".
l. Parking meters: coin slots or credit card swipes for accessible parking spaces or pay stations that serve accessible parking spaces shall be located at a maximum height of 43".

02. Accessible Parallel Parking Spaces (Passenger Loading Zones, similar)
a. Accessible parallel parking spaces are not the preferred type of accessible parking space, but may be the only option for providing accessible parking near a facility.
b. When provided, provide 8' wide by 19' long parking space with a 5' wide access aisle.
c. Provide accessible parking signage adjacent to the parking space from 4 feet behind the front of the parking space, angled toward the street.

03. Curb Ramps
a. Provide curb ramps where accessible routes cross curbs and where blended transitions are not provided.
b. Unless limited by existing conditions, provide maximum slope of 1:14 on ramp and flared surfaces.
c. Provide minimum 4' x 4' landing at sidewalk at top of curb ramp. Maximum slope on landings to be 1.5%.
d. Minimize the slope at the landing at bottom of the curb ramp to the greatest extent possible. Consider going to a blended transition at intersections where the crown of the existing street creates excessive slope at the gutter line.
e. Do not paint curb ramp surfaces.
f. Provide safety yellow detectable warning on all curb ramps that lead to a vehicular crossing. In general, driveways are excluded unless it is determined that the anticipated volume of traffic entering or exiting a driveway warrants detectable warning.

04. Site Furnishings

a. Where benches are provided, provide at least one fully accessible bench in each grouping of benches. Where multiple benches are provided, provide at least one accessible bench for each five benches in a grouping or portion thereof.
b. Provide companion seating adjacent to a minimum of the of 50% of all benches.
c. Where picnic tables are provided, provide at least one accessible picnic table in each grouping of picnic tables. Where multiple picnic tables are provided, provide at least one accessible picnic table for each five picnic tables in a grouping or portion thereof.

D. Interior Accessible Routes

01. Accessible Routes
a. Minimum width: 60” (ADA minimum is 36”.)
b. Design accessible routes without ramps whenever possible.
c. Elevators are preferred over ramps wherever level changes greater than three vertical feet are necessary.
d. Avoid the use of vertical platform lifts in new construction. In existing buildings, vertical platform lifts may be an option for making an area accessible, but should always be the last resort.
e. Ensure that the lighting levels on ramps and stairs are at least equivalent to the lighting levels in adjacent areas.

02. Interior Ramps
a. When a ramp is necessary, design the ramp slope between 1:20 and 1:16. (ADA allows 1:12 maximum slope for ramps).
b. Individual sections of ramps shall not be longer than 25’ without a level landing.
c. Install handrails at 36” above ramp surface. (ADA allows 34” – 38”). Also, include handrail at 26” in locations used primarily or frequently by children.
d. Avoid curved ramps.
e. Where possible, provide a minimum 60” x 72“ area at top, bottom, and intermediate landings.
f. Provide continuous handrails around the perimeter of landings.
g. When using steel pipe or tubing, provide minimum wall thickness of .140”.
h. Round handrails are preferred.

03. Interior Stairs
a. Do not design single stair condition.
b. Ensure that the leading edge of treads contrasts with the rest of the treads to increase visibility and safety where appropriate. Provide contrasting strip on the leading edge of the tread that extends a total of 2” back from the leading edge of each tread.

c. Install handrails at 36” above stair nosings. (ADA allows 34” – 38”.) Also, include handrail at 26” in locations used primarily or frequently by children.
d. OSSC requires that there be handrails within 30” of any portion of a stair that is determined to be an egress route. On stairs that are not part of an egress route, provide intermediate handrail(s) evenly spaced in increments not exceeding 8’.
e. Provide 12” horizontal handrail extension at the bottom of stairs providing the extension does not protrude into an accessible route.
f. Provide continuous handrails around the perimeter of landings.
g. When using steel pipe or tubing, provide minimum wall thickness of .140”.
h. Round handrails are preferred.

04. Elevators
a. Provide hall call buttons that fully illuminate and are bright and are easy to recognize when activated.
b. Use flat-surfaced, raised buttons because they are easier to activate than convex buttons.
c. Hall call buttons shall be located with the down button centered at a height of 35” above the floor. The up button shall not be located more than 43” above the floor (ADA allows a range of 15” to 48”; State Elevator Code allows a range of 35” to 48”)
d. All car controls and emergency buttons (inside elevator) shall be located so that the lowest button is centered at a height of 35” and the highest buttons is centered at a height of 48” or less . (The State Elevator Code requires all buttons to be located between the height of 35” and 48”.)
e. In public elevators serving high-use buildings, install two sets of buttons, one with the highest buttons located at 48” and the second set with the lowest buttons located at 33”. The lower set of buttons shall be mounted with the longest dimension horizontal.
I. The designer, project manager, and Office of Equity and Inclusion, in consultation with AUITF, during the project review process described in Part 2 above, shall determine whether or not a building would be considered “high-use”, on a case-by-case basis.
f. Provide a handrail on every wall of elevator cabs except those walls that have either doors or elevator controls. The handrails should be located at a height of 32”.
g. In new construction, provide at least one elevator cab that can accommodate an ambulance stretcher (84” long minimum). In

buildings that have an emergency generator, this elevator should be tied into the emergency system.

h. See Section 14 20 00 for additional elevator requirements.

E. General Building Elements

01. General Design

a. When designing rooms and spaces, include furnishings, trash receptacles, and other moveable objects in the design drawings to make sure these items will not encroach on accessible routes, turning spaces and required clear floor spaces. The design should incorporate space for these items.

02. Building Ingress and Egress

a. Where technically feasible, all public access points to a new building or major remodel/renovation should be made accessible.

b. In those cases where at least 60 percent of all public entrances cannot be made accessible due to technical infeasibility, the Office of Equity and Inclusion will be contacted and review the design prior to a final decision has been determined.

03. Access to Public Areas

a. In new construction and major renovation work, all public areas must be made accessible including multi-leveled classrooms, sunken areas, loggias, raised platforms, and mezzanines.

04. Areas of Refuge

a. Do not install areas of refuge.

b. Provide clear means of egress from all areas of a building.

05. Doors and Door Openers

a. Provide automatic door operators on all primary entrances to a building.

b. Install infrared sensors, push button controls, proximity card readers and other door control devices at a height of 36”.

c. Provide a clear floor space at these door control devices that is level and located outside the swing of the door.

d. Do not install doors that are narrower than 36” wide. (ADA requires a minimum 32” clear.)

e. Avoid doors that swing out into corridors or accessible routes of travel.

f. Install magnetic hold open devices or high quality automatic door openers on internal doors and fire doors in corridors, and other areas accessible entrances and along accessible routes within buildings.

g. The preferred height for handles, pulls, latches, locks, and other operable parts on accessible doors is 39 inches above the floor.

06. Windows

a. Provide adequate clear floor space at any operable window so that a person can approach and open the windows.

07. Furnishings
    a. Where seating, benches, tables and other furnishings are provided, provide a minimum of one accessible unit for every five units or portion thereof.

F. Plumbing Elements and Facilities
    01. Restrooms and Toilet Rooms
        a. In new construction and major renovation, all restrooms shall be designed to be fully accessible.
        b. All restrooms shall be designed either without doors or have automatic door operators. (See Section 08 71 00 Door Hardware.)
        c. In addition to the required restrooms per applicable building code requirements, at least one accessible family or assisted use restroom shall be provided. If only one restroom is provided, then it shall be located on the first floor of the building.
        d. All family or assisted use restrooms shall be provided with a Camden entry system. (See Section 08 71 00 Door Hardware.)
        e. In restrooms that include two or more toilets, provide at least one wheelchair accessible stall and one ambulatory accessible stall.
        f. In larger public restrooms containing six or more toilets, provide one wheelchair accessible stall and one ambulatory accessible stall for each six toilet stalls or portion thereof.
        g. Provide 48 inches minimum clearance between stall doors and any wall or obstruction. (ADA allows 42” for latch side approach.)
        h. Install automatic flush valves. Exception: Where dual-flush valves are used, lever controls are acceptable, but must be located in an accessible location.
        i. Install toilets so seat height is at 18” (ADA allows 17” – 19”) and centerline of toilet is 17” from wall (ADA allows 16” – 18”).
        j. Install grab bars at 34” height. (ADA allows 33” – 36”.)
        k. Install vertical grab bar as per ICC A117.1 (new requirement).
    02. Lavatories
        a. In new construction, make all lavatories accessible.
        b. .02
        c. Install automatic faucet controls.
        d. Provide tempered water (120 degrees maximum).
    03. Urinals
        a. Install automatic flush valves.
    04. Showers
        a. Install roll-in showers that are 42” x 60” minimum. (ADA allows 30” x 60”.)

b. Provide a clear floor space of 36” x 60” minimum outside of transfer shower stalls of and 42” x 60” minimum at roll-in shower stalls. (ADA allows 36” x 48” and 30” x 60”, respectively.)
c. Install shower seats at 18” height. (ADA allows 17” to 19”.)
d. Install shower controls at 43” (ADA allows 38” to 48”.)
e. Mount grab bars at 34” (ADA allows 33” to 36”.)

05. Locker Rooms
a. Provide accessible lockers on accessible route.
b. Accessible lockers should be located close to entrance to locker room and near showers.
c. Accessible lockers should be located within 18” to 43” reach range and be furnished with lever handles.

06. Toilet Accessories
a. Mount toilet paper dispensers below grab bars at 29” and out from the front edge of the toilet centered a distance of 8 inches. (ADA allows 7” – 9”.)
b. Mount toilet seat cover dispenser on opposite wall or partition from side grab bar. The opening should be at a maximum height of 43”.
c. Mount fixtures (including hand dryers, paper towel holders, and soap dispensers) with controls at 43”. (ADA allows up to 48” or 54” with clear side reach.)
d. Locate paper towel dispensers and hand dryers in locations that are not within an accessible route of travel. Consider using a recessed unit that does not protrude from the wall more than 4”. (The OSU standard paper towel dispenser protrudes out from the wall approximately 9 inches and does not comply with ADA requirements.)
e. The same applies to hand dryers.
f. If provided, install baby changing table so that the front edge is at 34” above the floor.
g. Mount mirrors with bottom edge no higher than 38” above the floor (ADA allows maximum of 40”.) Provide full height mirrors, where possible.

07. Drinking Fountains
a. Install dual-height accessible drinking fountains or water coolers near lecture halls, auditoriums and other high-use areas. (Option: two separate units.)
b. Provide water bottle fillers on the lower unit.
c. Provide alcoves for drinking fountains. Wheelchair accessible drinking fountains typically extend out from walls. This creates a potential protrusion hazard.

G. Communication Elements and features

01. Parking Signage
    a. See Parking above for accessible parking signage.
02. Exterior Signage
    a. When all entrances are not accessible, provide signage that directs people to accessible entrances.
03. Interior Signage
    a. Install tactile signage at stairways and elevators that are not accessible to direct people to the nearest accessible exits.
    b. Tactile exit signage should be provided wherever visual exit signs are required.
    c. Visual and tactile signage indicating the floor level should be provided at all stairwells.
    d. Provide the International Symbol of Accessibility on all restroom signage. (OSSC does not require the International Symbol of Accessibility if all restrooms are accessible.)
    e. Provide Grade 2 Braille on all signage required to have Braille. This is an abbreviated form of Braille.
    f. The base of all raised text and Braille is to be located between a height of 48” and 60” (New ADA requirement).
    g. Where pictograms are used, raised text and Braille should be located below the pictogram.
    h. All doors with automatic door operators should have signage on the door indicating that it is an automatic door. The signage should be on both sides of the door.
04. Assistive Listening Systems
    a. Where sound systems are installed, assistive listening devices shall be installed as part of the system.
    b. At least 25%, but no fewer than 2 receivers shall be hearing aid compatible.
    c. The assistive listening system shall be as specified in Section 27 40 00 Audio Visual Communications.

H. Special Rooms, Spaces, and Elements
01. Classrooms
    a. Design classrooms without ramps or lifts, whenever feasible.
    b. The slope of walking surfaces shall not exceed 1:20.
    c. If elevated stages are provided, they shall be on an accessible route.
    d. Provide minimum 42” clearance between aisles that lead to accessible seating.
    e. Wheelchair accessible spaces should be adjacent to an accessible route.
    f. A clear line of sight to the instructor and media shall be provided at wheelchair accessible spaces.

g. In classrooms with occupancy of 100 or more, wheelchair and accessible seating should be dispersed to provide a variety of viewing angles.
h. All accessible spaces and furniture shall be provided with signage indicating that the space is reserved for people with disabilities.
i. Spaces for wheelchairs should be a minimum of 36” wide by 48” deep (60” deep, if side access).
j. See draft Oregon State University Classroom & Furniture Accessibility Standards for more specific information about classrooms and furnishings.

02. Kitchens
a. Where kitchen ranges or stove tops are installed, provide units with controls located near the front of the units.
b. At kitchen counters, sink faucet controls shall be located within 20” of the front edge of the counter. Consider side mounted controls located with 16” of the front edge of the counter where feasible.

03. Cafeterias
a. The tops of tray slides shall be located at a height of 33” (ADA allows 28” to 34.)
b. Accessible self-service shelves and dispensing devices shall be located at a maximum height of 33” (ADA allows 15” to 48” or 44” over counters up to 25” deep.)
c. If dispensing devices are on a counter, the counter should be at a maximum height of 34”.

04. Research Stations and Laboratories
a. Provide a minimum of one accessible workstation. Provide one accessible workstation for every twenty workstations or portion thereof.
b. Accessible work stations should have counters and sinks at 34” maximum height and compliant knee space.
c. At an accessible work station, locate sink faucet controls along the side of the sink within 16” of the front edge of the counter. The outflow of faucet spigot shall not be located more than 16” from the front edge of the counter.
d. Provide controls for fans, fume hoods, gas valves, etc. at a maximum height of 43”. (ADA allows 15” to 48” or 44” over counters up to 25” deep)

I. Recreation Facilities

01. Fitness and Weight Room
a. Provide accessible fitness equipment that provides the same range of exercises and strength training provided by the rest of the equipment. Where feasible, provide some equipment that

can be used by both able-bodied individuals as well as persons with disabilities.

b. Provide minimum 42” clearance between all pieces of exercise equipment.

02. Pools and Spas

a. Provide at least two accessible means of access into all pools. At least one of these means of access should be either a pool lift or a sloped entry.

b. Provide at least one accessible means of access into all spas. The accessible means of access should be either a pool lift, transfer wall or transfer system.

Section 01 00 00 – GENERAL

1. PROJECT DRAWING REQURIEMENTS
   A. For projects that do not include an A&E design firm or are self-performed by OSU, the Owner requires the receipt of marked-up record drawings indicating modifications, dimensions, equipment lists and other information necessary for ongoing operations and maintenance.
   B. For projects that include an A&E design firm, the Owner requires the following:
      01. The Construction Drawings will be plotted on sheets not exceeding 30x42".
      02. All documents and drawings shall include the Owners Project Number and Title Block.
      03. The design professional will also provide the Owner with a complete set of 'Record' drawings on archival-grade vellum, and a full-size scanned image of each sheet in PDF format at a minimum resolution of 400dpi. All PDF files shall be correctly oriented (right-reading).
   C. The Owner requires the receipt of a complete set of the construction documents and Book Plan files (see section J.) in digital form at the following stages:
      01. 100% Construction or Bid and
      02. Record (as-constructed) drawing
   D. If the work is performed through the OSU Shops, the appropriate vendor, contractor or internal construction group is responsible for providing these drawing updates at the completion of the project.
   E. All 'External References' (including nested ExRefs) must be included and fully resolved.
   F. When submitting the final 'Record' drawing files, all exrefs shall be bound to the parent file using the 'insert' option of the 'Bind exref' dialog.
   G. All AutoCAD data must be accompanied by the proper plotter configuration file(s) and any font (shx), shape (shp) or proprietary files necessary for reproduction.
   H. If 'vertical applications' are used in addition to a basic AutoCAD installation, the design professional shall include the correct AutoDesk 'object enabler' file(s) for resolution with a basic install of AutoCAD.
   I. Life Safety Cover Sheets
      01. All architectural drawings will include life safety cover sheets which should include:
         a. Zoning requirements
         b. Required side yards
         c. Fire resistivity of exterior walls
         d. Fire classification of the building's construction type
         e. The sheet will include a schematic drawing indicating:
            1. Required exit corridors and the required fire classification of walls, doors, windows, and duct work.
            2. Area separation

3. Flame spread characteristics
4. Rated ceilings
5. Allowable areas or occupancy types
6. Number of stories, basements, and attics
7. Other elements important to a zoning/life safety code check.
8. Identify exit corridors.

J. Book Plans
   01. Book Plans are the drawing of record for OSU space on and off campus.
   02. Book plans shall be drawn to scale and printed on 11" x 17" sheets.
   03. OSU will provide the appropriate title block and drawing layers.
   04. Creation/updating of book plans is required for every new and remodel construction project.
   05. Book plans shall be prepared for all affected floors including:
      a. Basement
      b. First Floor and all floors above the first floor
      c. Attic and/or roof.
   06. Book plans should include the following information:
      a. Building identification
      b. Floor identification
      c. Room numbers
      d. Use of space (i.e. lab, classroom, mechanical room, corridor)
      e. General interior and exterior dimensions
      f. Net useable area for each room
      g. Total square feet calculations – gross area and net useable area – for each affected floor.

K. Building Map
   01. Provide an "11x17" building map that clearly identifies the location of the building exits, elevators, fire extinguishers, ADA restrooms, men's restroom, women's, restrooms, unisex restrooms, fire alarm pull stations, and closest exit.

L. When a project involves the modification of public utilities (PICP) the Owner requires 2 sets of digital and hard copy 'Record Drawings' within 30 days following the City of Corvallis' approval of that portion of the construction. The Design Professional shall provide one set to City of Corvallis Public Works Department, and one set to the Owner.

2. SUSTAINABILITY

A. Oregon State University shall follow the Sustainability Facilities Standards and Guidelines outlined in the Oregon Department of Administrative Services to follow Policy Manual number 125-6-010.
   01. All new buildings are required to reach a minimum of 33 sustainability points out of a possible 65.

02. All major remodeling projects are required to reach a minimum of 26 sustainability points.

B. Certain sections of the Construction Standards and Specifications have been modified to guide accomplishment of this goal. It is the responsibility of the A/E to review these and other applicable criteria for appropriate inclusion.

3. UNIVERSAL DESIGN

A. It is the intention of Oregon State University to develop a built environment which is universally designed to incorporate access for persons with disabilities as an integral element in anything built or purchased. The designer will take the initiative to provide these accommodations, which are not separate or special, but rather are universal in utility. Successful examples that accommodate the greatest diversity of human characteristic and enhance a esthetics are:

01. Grade level building approaches with automatic snow melting rather than separate unheated ramps and steps provide hazard free entrances for everyone.
02. Signs on automatic doors that read "automatic door" rather than a barrier free logo. Mobility aid users can select which door to use like everyone else.
03. Lever-handle hardware, which is more convenient for everyone.
04. Exit signs that flash when an emergency alarm is activated, which reinforces that an emergency exit condition exists and warns the hearing impaired as well.
05. Low service counters, where possible, to be equally functional for wheelchair users and non-wheelchair users.
06. Room number signs with raised or incised characters, which can be read by touch as well as by sight, and at a standard mounting height.

B. Refer to Section 13200 – Universal Access for more information.

4. SITE PLANNING

A. All site planning, design and development for new and existing construction (e.g., renovations and remodels, additions) for any building or structure located within the Campus Master Plan boundary shall conform with the policies and regulations within the Campus Master Plan. In addition the development project shall conform to all applicable land use regulations per the OSU Zoning District. A copy of the Campus Master Plan and the OSU Zoning District, Section 3.36 can be obtained by contacting Campus Planning. Section 3.36 can also be obtained from the City of Corvallis Planning Department. http://www.ci.corvallis.or.us/

B. The siting of new construction within the Campus Master Plan boundary is subject to review and approval by the Campus Planning Committee (CPC). (Refer to the CPC Development Review Process Requirements.)

C. The siting and design of the building shall conform to applicable design guidelines set forth in the Campus Master Plan and the OSU Zoning District. No

deviation for set guidelines and regulations shall be permitted without approval from the Director of Facilities Services.

D. Site work drawing shall include at a minimum:
   01. Any drawings necessary to meet minimum submission requirements for the City of Corvallis'
   02. Proposed footprint of new building or structure;
   03. Adjacent streets; sidewalks, paths, etc.
   04. Existing lighting;
   05. Landscape features; and
   06. Parking areas

5. MECHANICAL AND PLUMBING DRAWINGS
   A. Respond to all design review comments and incorporate them into the drawings and specification as appropriate.
   B. Provide complete drawings suitable for competitive bidding. Drawing packages must include the following as appropriate:
      01. Life Safety Cover Sheet
      02. Legend Sheet
         a. The legend sheet shall include all symbols used on the drawings with a description of what that symbol indicates. The symbols used shall comply with industry standards.
   C. Schedule Sheets
      01. Schedules for new and existing mechanical equipment shall include all performance data including capacity, air/water pressure drops, rpm, entering and leaving conditions, motor horsepower, KW, or amps, voltage/phase, basis of design manufacturer, location of equipment, identification numbers, unit physical dimensions, and weight.
      02. In the upper right hand corner, on the first sheet of the plumbing drawing, or on the title sheet of projects without separate plumbing drawings, include a 01."PLUMBING FIXTURE SCHEDULE." This information will be used in determining the fixture count for the City of Corvallis review.
      03. List all abandoned, demolished or deleted fixtures as well as the new fixtures.
      04. Plumbing fixture schedules shall include fixture identification, connection sizes for water, waste and vent, and gases.
   D. Riser Diagrams
      01. Modification to existing systems shall include the riser diagram for the existing systems and piping back to the nearest main branch.
      02. Include diagrams for all mechanical systems including heating water, chilled water, condenser water, and refrigerant piping.
      03. Include diagrams for all waste and vent systems, hot and cold water, and storm water systems.
      04. Fire protection one line riser diagrams.

E. Underground and Foundation Plans

F. Indicate all buried piping, starting invert elevations, and invert elevations at point five feet outside building. Provide invert elevations on underground sanitary waste, storm, water, and other underground piping on plans.

FLOOR PLANS

01. Show all ductwork, piping, and equipment on floor plans at a scale to match the architectural.

02. Provide Enlarged or Partial Plans to adequately show the work in complex or confined installations.

G. Show locations of steam system anchors, slides, guides, and expansion joints.

Sections and Details

01. Provide building sections to show locations of mechanical system components in relation to building elements. Mechanical components shall be coordinated with work of other trades.

02. Provide details for mounting or connection of equipment.

03. Provide pipe support and anchoring details for steam piping 4 inches and above.

Mechanical rooms shall be detailed at no less that ¼" per foot with piping and ductwork shown double line. Drops and offsets shall take into consideration the actual space it takes to make connections and turns.

6. SPECIFICATIONS

A. Submit, as part of the design development package and at each construction document review stage, a list of equipment and the manufactures to be used on the project in the following CSI format:

1.		2.	3.	4.

7. STORM WATER MANAGEMENT

A. Discharge of pollutants (any substance, material, or waste other than clear, uncontaminated storm water) into a storm drain system or a water body is prohibited by the Department of Environmental Quality (DEQ).

B. Any proposed new development or expansion of development along an open natural drainage way shall comply with OSU Zoning District Section 3.36.50.07 – Drainageway Management Agreement.

Where applicable, consider water quality and/or detention swales that use biological methods for water purification to address unavoidable post-development storm water sources.

C. Storm water runoff from loading dock areas shall be drained to a sanitary sewer system where feasible. Where sanitary sewer is not available, best management practices must be implemented.

D. All wastewater generated from water wash down and other cleaning activities within confined animal facilities and that contacts manure areas must be handled so as to not impair ground or surface water quality.

8. HAZARDOUS MATERIALS
   A. Hazardous materials described in the following section refer, at a minimum, to asbestos, lead, mercury, PCBs, and containerized chemicals.
   B. On every project involving existing facilities, a hazardous materials survey shall be performed prior to any demolition. This survey will be performed by OSU Facilities Services Environmental Health and Safety (EH&S) or by independent consultants as directed by EH&S.
   C. The survey will provide an overview of typical surfaces and locations containing the hazardous material in question but may not specifically delineate every location where the hazardous material may be found. Under no circumstance shall demolition work occur prior to approval from OSU EH&S.
   D. All contractors are responsible to contacting OSU EH&S prior to any construction activities or demolition of existing structures within an OSU building. Removal of asbestos shall be performed by an OUS-approved asbestos contractor under the direction of OSU EH&S. Refer to Section 02120 – Asbestos Abatement.
   E. Lead abatement projects shall be performed by OUS-approved lead abatement contractor under the direction of OSU EH&S. Lead abatement projects have the intent to remove (or encapsulate) lead surfaces to make them less hazardous.
   F. Demolition of surfaces with lead-containing paint is NOT lead abatement. If contractors, for any reason, cannot perform demolition on lead-containing materials, a separate contractor will be hired by OSU for that work.

9. SPACE ALLOCATION
   A. The University Space Committee has approved a Space Allocation Model which is implemented by Facilities Services. Information about OSU's Space Allocation Model can be found at http://oregonstate.edu/osusc/, or from Campus Planning.

10. OSU HISTORIC DISTRICT
   A. Development in the OSU National Historic District is subject to the requirements of the City of Corvallis Land Development Code, Chapter 2.9 – Historic Resources. All historic preservation permit applications (HPP) will be submitted for review, coordination and disposition by Campus Planning.

11. BUILDING EXTERIORS
   A. All exterior building features must meet or exceed Oregon Energy Code, Chapter 13, of the current Oregon Structural Specialty Code, and the current Oregon Occupational Health & Safety Code requirements.
   B. Select materials for compatibility with adjacent structures per Campus Master Plan design guidelines.
   C. Exterior brick for the envelope must be of the highest quality selected for harmonious color, texture, appearance, the Pacific Northwest climate, and environmental impacts.
   D. Metal coping is required on all brick or masonry parapets.
   E. Asbestos containing materials are not allowed.

F. Provide exterior architectural louvers with factory finish that does not require field painting. Exterior louvers to be specified by the architect.

12. EH&S MITIGATION REQUIREMENTS: Environmental Mitigation requirements may included, but are not limited to, procedures and standards to control:
    A. Dust Control and Fugitive Emissions.
        01. Construction project activity shall not cause or permit the emission of any particular matter at sufficient duration or quantity as to create a nuisance or observable deposition upon real property of another person.
        02. Reasonable precautions to control particulate emissions can include but are not limited to:
            a. Use of water or chemicals for control of dust during demolition of structures, construction, or during grading of roads or clearing of land.
            b. Covering at all times when in motion, open bodied trucks transporting materials likely to become airborne.
            c. Full or partial enclosure of stockpiled materials.
            d. Dirt or debris spilled onto paved surfaces should be swept up immediately to reduce re-suspension of particulate matter caused by vehicle movement.
    B. Odors
        01. Work that causes excessive odors shall be performed only after coordination with the University's Representative. Filtering of air intakes may be needed to prevent odors and vapors from entering buildings.
        02. In cases where unavoidable odors will be produced, Contractor shall provide 7 business days advance notice to the University's Representative in order that adequate notice can be forwarded to building occupants. Work stoppage may occur if advance notification has not been coordinated or odors and vapors from the work are found to generate complaints from building occupants.
    C. Protection of Existing Air Handling Systems
        01. Contractor shall be responsible for protection of the cleanliness of existing air handling systems at all times. This protection may include as needed:
            a. During site work or building demolition, pre-filters shall be provided and maintained on all building outside air intakes at all times throughout the construction duration.
            b. During any interior work that may create dust in the interior space and adjacent corridor/hallways, air filters shall be provided and maintained on all affected air return and exhaust grilles. Where air flow in or out of the space is not required, all air duct openings shall be temporarily sealed off with a suitable covering.
            c. Upon completion of all Work affecting existing air handling systems, the Contractor shall remove all temporary filters, covers

and associated parts and restore the system to its original operating condition unless otherwise stated elsewhere in the Contract Documents.

D. Ventilation during Painting or Other Finish Work
   01. The room/space shall be supplied with 100 percent outside air during painting and for a period of 72 hours following completion of painting.
   02. The air leaving the room/space shall be exhausted only to the outside, with no re-entrainment to any occupied spaces during painting and for a period of 72 hours following completion of painting.

E. Construction and Maintenance Isolation Requirements
   01. All construction, maintenance, and remodeling activities, regardless of size or scope, must be fenced, barricaded, or otherwise isolated to restrict entrance and to ensure the safety of those in the general area.
   02. The contractor will provide all barricading, isolation, and fencing material. The contractor will also provide all appropriate warning and detour signs when sidewalks, exits, or roads are closed.
   03. The contractor shall submit the OSU Construction & Maintenance Safety Form and OSU Site Safety Plan to the OSU PM at least 1-week prior to commencing work. Both forms are accessible on the OSU EH&S web site.

13. NON STRUCUTURAL SEISMIC BUILDING ELEMENTS

A. Falling hazards from non-structural building elements including equipment, fixtures, ceilings, furniture, and other contents should be abated, to the extent practical. This includes the following guidelines:
   01. Free-standing bookshelves, cabinets, and equipment shall be anchored according to the seismic design requirements of the International Building Code (as modified by applicable State Codes).
   02. Shelves shall have doors or restraints to keep items from falling. For bookshelves, the restraint should extend at least on-half inch above the shelf. For chemicals and in other laboratory areas, the restraint should extend at least two inches above the shelf. Where glass chemical containers will be stored, the restraint material should be of a nonmetallic or a rubber coated metallic material.
   03. Shelving shall be provided with a lip or guard when used for the storage of individual containers of hazardous materials.
   04. Sliding or swinging cabinet doors shall have mechanical latches.
   05. Compressed gas cylinders shall be restrained using approved brackets with two metal straps or chains that have been firmly attached to walls. When using chains, one should be located approximately 8 inches from the floor and the second should be located approximately 34 inches from the floor.
   06. Flexible utility connections shall be used for fume hoods and other equipment.

07. Biosafety cabinets and fume hoods should be seismically anchored.

14. REFLECTED CEILING PLANS
    A. The reflective ceiling plans shall locate lighting fixtures, sprinkler heads, supply air diffusers, return air registers and all equipment mounted to or suspended from the ceiling.
    B. Lighting located to serve work stations may determine the direction of a ceiling grid pattern.
    C. Lighting located to serve work stations may influence location of fire sprinkler heads.
    D. Lighting located to serve work stations may influence supply and return air inlets and outlets.
    E. Orientation of the lighting fixtures may dictate that the ceiling grid be broken to accommodate some lighting fixtures.

15. ROOM NUMBERING
    A. OSU has a specific system of numbering rooms within a building. Contact the Facilities Services Project Manager to arrange floor plan review for a numbering appointment.
    B. This designation should be done before submittal of 50% development documents. The OSU system will allow for changes in plan without disrupting the numbering of other spaces.

Section 01 56 39 - TREE AND PLANT PROTECTION

PART 1 - GENERAL

1. REQUIREMENTS
   - A. The contractors shall furnish all labor, materials, equipment, and services necessary for the protection of existing trees and vegetation as required and as specified herein.
   - B. The plans shall include annotation that indicates it is the responsibility of the General Contractor to repair, replace, or reimburse OSU for any damaged plant material within a Tree Protection Zone.
   - C. All landscape materials shall be protected to ensure they are not damaged.
   - D. All staging areas located on planting areas shall be covered with woven geotextile fabric and have a minimum six inch mulch bed placed over area prior to any staging of equipment or materials to prevent soil compaction.
     - 01. All vehicular or motorized equipment access to a staging area over turf shall be covered with woven geotextile fabric with a minimum of six inches of mulch bed placed over the area to prevent the compaction of soil.
   - E. The General Contractor is responsible for removing all construction or construction related debris from the project site and adjacent landscape or shrub beds.

2. DEFINITIIONS
   - A. Tree Root Protection Zone (TRPZ): An area that generally extends from the base of the tree trunk beyond the dripline of the tree.
   - B. Dripline: Outer perimeter of branches of any plant.
   - C. Project Arborist: A certified arborist with the experience to conduct the required work outlined in this section shall be employed by the University.

3. CALCULATING THE TREE ROOT PROTECTION ZONE
   - A. Measure the tree's diameter at breast height (DBH), in inches. DBH is calculated using the circumference of the tree trunk at 4.5 feet above grade.
   - B. Multiply the DBH by 1.5.
     - 01. Example = 7" DBH x 1.5 = 10.5'.
   - C. The result expressed in feet shall be the minimum radius of the TRPZ.
   - D. For trees less than 8" in DBH, the TRPZ shall not be less than the diameter of the canopy dripline.
   - E. For shrubs scheduled to remain the protection shall be the dripline of the existing plant or plant grouping.

4. COORDINATION
   A. The project arborist will coordinate with other trades and contractors affecting or affected by work of this section to ensure that tree protection measures are understood prior to work commencing.
   B. An on-site review of tree protection measures will be completed among the project arborist, contractor, OSU Project manager, City of Corvallis, and OSU Landscape Manager or designee prior to any site work or grading is started.
   C. During this meeting the pre-construction evaluation of those trees identified to remain shall be completed.
   D. The contractor is responsible for maintaining all tree protection measures during all construction phases of the project.
   E. The project arborist and OSU Project Manager and OSU Landscape Manager or designee shall be contacted immediately if any of the trees on site are damaged during the construction of the project. The project arborist in consultation with the OSU Project Manager and OSU Landscape Manager or designee will assess the damage to any tree and provide corrective measures, which may include pruning; tree wound repair, or even removal.
   F. Upon completion of the project the project arborist will contact the OSU Project Manager and review the post construction evaluation of the trees on the site.
   G. No tree shall be removed from the site without the completion of a tree condition report and prior notification and approval of the OSU Project Manager.
      01. Tree removal within the OSU National Historic District requires a Historic Tree Checklist to ensure that any trees being removed are not considered historic. An arborist report must accompany the Historic Tree Checklist.

PART 2 – MATERIALS

1. FENCING
   A. The contractor is responsible for installing a tree protection fence around all the trees identified to remain on site prior to the start of any site work, grading, or staging of any equipment or materials.
   B. The tree protection fence shall be a galvanized chain link fence that measures a minimum of six feet high.
      01. The fence shall be secured using steel posts that are the same height as the fence.
      02. The steel posts shall be driven no less than two feet into the ground, and be a minimum of ten feet apart.

2. SIGNAGE
   A. A highly visible sign shall be posted on the chain link fence demarking the area as a tree root protection zone. The sign shall remain posted and unobstructed until the project is completed.

PART 3 - EXECUTION

2. ASSESSMENT

A. Pre-Construction Tree Assessment: Prior any site work, grading, staging of equipment, materials or any other mobilization of the project, the project arborist shall complete a pre-construction assessment report that outlines the physical conditions of the trees identified to remain on the site. The project arborist shall review the report with the OSU Project manager and the OSU Landscape Manager or designee.

01. The OSU Landscape Manager or designee shall provide written notification to the project arborist that the report has been reviewed and is acceptable prior to the mobilization of the project.

02. The assessment report shall provide any specific tree protection measures required to ensure the health and vigor of the trees during the construction of the project.

03. The assessment report shall also include a value appraisal of the trees completed according to the most recent Council of Tree and Landscape Appraiser standards (currently the 9th edition, copyright 2000).

a. The value of the trees that are to remain will be provided to the contractor prior to the mobilization of the site to ensure the contractor is aware of the replacement cost of the trees as outline in the appraisal report.

B. Tree Protection Areas: Prior any site work, grading, staging of equipment, materials or any other mobilization of the project the contractor shall establish the tree root protection zones and install the specified fencing.

C. This protection area shall be maintained by the contractor during all phases of construction and only removed upon demobilization of the site.

D. In consultation with the OSU Project manager and OSU Landscape manager or designee, the project arborist shall recommend corrective measures for any tree damaged during construction,

01. Prior to any removal of a damaged tree the project arborist will ensure a replacement cost is determined for the damaged tree.

E. The project arborist shall complete a post construction assessment of the trees to determine the condition of the trees. The report shall be submitted to the OSU Project Manager and OSU Landscape Manager or designee for review and approval.

01. The OSU Landscape Manager or designee shall provide written notification that the post construction report has been reviewed and accepted prior to the close out of the project.

3. PROTECTION
   A. There shall be no alteration or disturbance of existing grade of any kind within the TRPZ.
   B. No alteration of drainage flow into the TRPZ shall be permitted without the written authorization from the project arborist.
   C. No storage of construction materials, equipment or supplies of any kind shall be permitted within the TRPZ.
   D. No disposal of any liquids of any kind shall be permitted within the TRPZ.
   E. No movement of vehicles, equipment, pedestrians, etc. shall be permitted within the TRPZ.
   F. No excavation or trenching shall be permitted within the TRPZ.
   G. No tunneling under the TRPZ without prior written authorization from the project arborist and landscape coordinator.
   H. No roots extending beyond the TRPZ shall be pruned or cut without prior authorization from the project arborist.
   I. No exceptions of the tree protection measures shall be provided without written approval from the OSU Project Manager and the OSU Landscape manager or designee.

4. PLANS
   A. All site and landscape plans shall identify the trees that are to remain, the trees to be removed, the tree root protection zone and protection fencing.

5. TREE DAMAGE AND REPAIR
   A. Upon notification of a damaged tree the project arborist shall inspect the tree and assess the damage. The arborist shall outline in writing the corrective measures necessary to repair the damage.
   B. If a tree is to be removed as a result of construction related damage then the cost of the removal and replacement and one year establishment care of the tree shall be the responsibility of the general contractor.
   C. Tree Replacement
      01. Up to8” DBH : Same size as damaged tree, species selected by Landscape Architect after consulting with OSU Project Manager and OSU Landscape Manager or designee.
      02. Over 8” DBH : Compensate owner as determined by value appraisal completed by project arborist according to the most recent Council of Tree and Landscape Appraiser standards.
   D. Replacement shrubs and groundcovers: Same size and quality as damaged, species selected by project Landscape Architect in consultation with the OSU Project Manger and OSU Landscape Manager.

Section 02 41 00 – DEMOLITION

1. REQUIREMENTS
   - A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
   - B. Demolition and disassembly will not be allowed until it is coordinated with OSU's designated representative.
   - C. Maintain free and safe passage to and from buildings during demolition.
   - D. Prevent movement or settlement of structures.
   - E. Provide and place bracing, shoring and underpinning, and be responsible for safety and support of structures and assume liability for such movement, settlement, damage or injury.
   - F. Cease operations and notify OSU's designated representative immediately if safety of structure appears to be endangered. Take precautions to properly support structure. Do not resume operations until safety is restored.
   - G. All active utility mains traversing the project site shall be maintained.
   - H. When removing a structure or building, establish a safety perimeter or corridor that restricts public access during the demolition operation. Provide, erect and maintain barricades, lighting and guard rails as required to protect the public.
   - I. Any unearthed underground tank shall be removed in accordance with applicable Department of Environmental Quality regulations and standards. Contact the OSU designated representative immediately upon discovery of an underground tank or sub surface structure. (See Section 02100)
   - J. On every project involving existing facilities, a hazardous materials survey shall be performed prior to any demolition. This survey will be performed by OSU Environmental Health & Safety (EH&S) OR by independent consultant as directed by EH&S. (See Section 01100 – 13 Hazardous Materials)

2. COORDINATION
   - A. Cooperate with Oregon State University and utility companies whose work affects or will be affected by the demolition operations. It is the professional consultants' and contractors' responsibility to ascertain and understand the rules, regulations and requirements of these authorities which affect the demolition process; notify them of conditions affecting their work, and disconnect or arrange for disconnection of utility services if required.
   - B. The professional consultant or contractor shall comply fully with all provisions of the local codes, laws and ordinances applicable to work of this Section, and other OSU plans and documents that relate to campus planning and development.

3. SUBMITTALS
   - A. The professional consultant or contractor shall be required to submit all the required documents identified in local codes and ordinances applicable to work

of this Section, and/or during the pre-planning, pre-construction, and/or construction meetings with project review team.

B. The required number of copies shall be submitted to OSU.

C. The documents shall include scaled drawings per:

01. Section 01100 – General Requirements and Division 1
02. Proposed building or structure to be removed;
03. Proposed walls, building systems, structures, etc. to be demolitioned within an existing building;
04. An indication of how building systems (e.g., HVAC, electrical, gas, water, etc) shall be capped where they were once connected to the portion identified for demolition;
05. Access route to a building or structure to be demolished;
06. Tree Root Protection Zone (TRPZ) for trees immediately adjacent to the demolition site or access route to the demolition site.

4. PRODUCTS

A. Salvaged materials

01. Owner shall have the option of retaining ownership of any or all existing equipment, materials, and items removed under this Work.
02. Should Owner decide not to retain ownership of certain items removed under the work of this Section, those items shall become property of Contractor and shall be promptly removed from the Project Site.
03. Deliver items which remain property of Owner to a location, or locations.

Section 02 65 00 – UNDERGROUND STORAGE TANK REMOVAL

1. REQUIREMENTS
   - A. This Construction Standard covers the requirements for removal and disposal of underground storage tanks and piping, backfill, products remaining in the tanks, contaminated soil and ground water, and related work in accordance with Federal, State, and local regulations.
   - B. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
   - C. Provide all labor, materials and equipment as necessary to complete all work as specified herein.
   - D. Work includes removal and disposal of an underground storage tanks and piping, and excavation and disposal of contaminated backfill, soil and groundwater. In addition, the work will include the installation of any temporary fence, barricade systems, or other means to keep the project site and work area safe and restricted from public access.
   - E. Perform work in accordance with local, Oregon OSHA, and Oregon DEQ regulations.
2. LICENSING
   - A. The tank removal contractor, subcontractors, and personnel employed on the project shall furnish proof of and abide by the following as applicable:
     - 01. DEQ Underground Storage Tank Rules
     - 02. Fed-OSHA and OR-OSHA rules, including Haz-Woper Certification
     - 03. Submit training certification statements for personnel performing work in accordance with DEQ's licensed "Service Provider" requirements.
3. EXCAVATION AND MATERIAL HANDLING PLAN
   - A. Contractor shall submit an Excavation and Material Handling Plan to OSU EH&S for approval.
   - B. The Contractor shall furnish all labor, materials, necessary permits, reports, and equipment to complete the work as defined in the project scope.
   - C. The plan shall address waste disposal that details transport and disposal methods for the: tank and piping, uncontaminated and contaminated backfill, soil and groundwater.
   - D. Contractor shall arrange for the transport and disposal of the tank, piping, contaminated and uncontaminated backfill, soil and ground water in accordance with local, State, and Federal laws and requirements. Components of the Plan should address:
     - 01. Excavation: Describe the methods, means, equipment, sequence of operations and schedule to be employed in the excavation, transport, handling, and stockpiling of soil during underground tank removal and disposal operations.

02. Tank Removal: Describe methods, means, sequence of operations, and schedule to be employed in the pumping, cleaning, de-vaporizing, inspecting, removal, and disposal of underground storage tanks and piping.

03. Soil and Groundwater Removal: Describe the phases of handling the contaminated backfill, soil and ground water. Include methods of excavating, handling of contaminated material, safety precautions and disposal requirements.

E. Prior to work commencing, the Contractor is responsible for obtaining waste disposal approvals from DEQ, OSU EH&S and the City of Corvallis as applicable.

F. The Plan shall specify final destination and modes of transport for all materials removed from the site.

G. Contractor shall address over-excavation and groundwater removal plans based on consultant and OSU recommendations for site cleanup levels.

4. SITE SAFETY AND HEALTH PLAN

A. The Contractor shall submit to the (EH&S) for approval a Site Safety and Health Plan (SSH Plan).

B. The SSH Plan shall include a site map, points of entry access routes to the project site from adjacent streets.

01. The SSH Plan shall be prepared in accordance with all applicable local, State and Federal laws and requirements for the work described herein.

a. EH&S shall be contacted immediately in cases of accidents, unforeseen events, or other incidents that need immediate attention due to a safety or health risks and or concerns.

5. PERSONNEL PROTECTION

A. All personnel assigned to perform work as described herein have the responsibility to have and appropriately use the necessary personal safety equipment and protective clothing.

B. No one is permitted on the project site without the required and appropriate personal safety equipment or protective clothing.

C. All personnel and equipment shall be decontaminated as needed before exiting the project site.

6. FIRST AID AND EMERGENCY RESPONSE EQUIPMENT AND PROCEDURES

A. The appropriate emergency first aid equipment for treatment of exposure to site physical and chemical hazards shall be readily accessible.

B. A list of emergency phone numbers and points of contact for fire, hospital, police, ambulance, and other necessary contacts shall be clearly posted at the job site.

C. A route map that details the directions to the nearest medical facility shall be clearly posted at the job site.

7. TEMPORARY CONTAINMENT OF EXCAVATED SOIL
   A. EH&S shall designate and approve the location of any temporary containment area proposed to be used by the contractor.
   B. The excavated soil shall be placed on an impervious barrier and covered with 10mil or greater polyethylene sheeting and shall be so constructed as to not allow any off-site discharge.
   C. The area will be restored to a pre-project state upon completion of the project.

8. EXCAVATION – refer to Section 31050 – Earthwork

9. TESTING
   A. Soil and groundwater sampling for purposes of environmental characterization will be performed by a 3rd party consultant per DEQ regulations. Contractor to coordinate sampling times with the 3rd party consultant.
   B. Testing of the tank, piping, soil and ground water for purposes of waste characterization and disposal will be the responsibility of the contractor.

10. INSPECTIONS
   A. The Contractor shall arrange for all required inspections in accordance with all applicable permits, and local, State and Federal laws and requirements.

11. CLOSURE REPORT (SITE ASSESSMENT REPORT)
   A. The Contractor shall provide EH&S a Closure Report that includes the field reports, records, inspections, or other documents obtained during the completion of the work described herein.
   B. Description of work completed including removal procedures, tanks and associated tank equipment, backfill, soil, and groundwater removed and disposed of.
   C. The Report shall address at minimum:
      01. Site plan showing location of tank and surrounding features and the limits of the excavation.
      02. Tank and piping disposal paperwork, contaminated backfill, soil and ground water disposal paperwork and any other documents required to comply with local, State, and Federal laws and regulations.
      03. Completion of DEQ required tank closure reports.
      OSU EH&S may request additional information upon review of the Report.

Section 02 82 00 – ASBESTOS REMEDIATION

1. REQUIREMENTS
   A. On every project involving existing OSU facilities the Project Manager shall ask that OSU Facilities Services Environmental Health & Safety (EH&S) survey for the existence of asbestos.
   B. No removal of building materials or building systems shall occur without the inspection for asbestos-containing material by the EH&S, OR by an independent consultant as directed by EH&S.
   C. All asbestos containing material that needs to be removed in support of any project will be coordinated by EH&S. Exemptions for OR-OSHA Class 2 asbestos work can be made by the University.

Section 07 10 00 – ROOFING AND WATERPROOFING

1. GENERAL REQUIREMENTS
   - A. Indicate applicable American Society for Testing and Materials (ASTM) specification in this section.
     - 01. Fire resistance based on ASTM E-108
   - B. Indicate applicable Oregon Structural Specialty Code, latest edition
   - C. Indicate applicable Underwriters' Laboratory (UL)
     - 01. Fire resistance based on UL- 790
   - D. Indicate applicable Factory Mutual (FM) specifications
     - 01. Wind uplift criteria based on FM 1-90
   - E. Note: indicate applicable National Roofing Contractors Association standards.
   - F. No new clay tiles roof are permitted
   - G. All work described in this standard shall comply with the current editions of the following codes as adopted by the City of Corvallis Municipal Code and the latest edition of the International Building Code
   - H. Waterproofing systems shall be used at all building planters, plaza decks, and
   - I. Any and all overflow drainage from roof shall be managed in accordance with applicable municipal code requirements. All attic and/ or under deck ventilation shall be installed as required to control moisture.
   - J. Moisture control:
     - 01. Install condensation control/ vapor retarders as required per the needs of the roof system.
     - 02. All attic and/ or under deck ventilation shall be installed as required to control moisture.
   - K. Testing for water tightness and material performance may be required at OSU's discretion prior to OSU's acceptance of roofing and drainage systems. Obtain acceptance of testing method from Owner and roofing materials manufacturer
   - L. Refer to Division 22 for additional information on Roof Drains.

2. FALL PROTECTION:
   - A. All roofs requiring maintenance must have fall protection from one of the following methods, or a combination thereof:
     - 01. Parapet wall [preferred]
     - 02. Guardrails [consider/minimize visibility of the guard rails from the ground or adjacent buildings]
     - 03. Tie-offs [provide specialized equipment and access from roof hatches]

3. MANUFACTURER QUALIFICATIONS
   - A. The Manufacturer's Roof System Warranty: Single source not less than 20 years, No Dollar Limit (NDL) labor and material for entire system including system and other roof systems.

B. Manufacturer shall have manufactured products continuously by same company for a period of time not less than ten years.
C. Manufacturer shall not be in any form of bankruptcy.
D. Manufacturer shall be the primary manufacturer of the membrane system.

4. ROOFING
   A. All roof designs and specifications shall be reviewed and approved by OSU Project Manager.
      01. All roof projects completed in the OSU National Historic District must be coordinated with Campus Planning.
   B. The existing architecture of the building will be accommodated.
   C. Install attic draft stops as required by Building Code.
   D. For renovations allroofs shall be provided with code compliant fall protection systems.
   E. For new construction, mechanical equipment located on roof must be screened by the parapet or screen wall or installed in a penthouse.
   F. All roofs require access for maintenance of equipment, roof drains, etc.
      01. Provide walking/tread pads from point(s) of egress to the roof to point(s) requiring maintenance.
      02. The walking tread pad material must be manufactured by the roof system manufacturer.
      03. The walk pads must be placed in the design, such that all locations requiring maintenance are accessible from the walking surfaces.
   G. All roofs shall be constructed or installed in a manner that provides for positive drainage without ponding or the occurrence of standing water to a drain per all applicable building code requirements and related specifications and standards.

5. ROOF INSULATION
   A. Provide separation board suitable for attachment to structure, as a base for roofing or insulation and to provide for required fire ratings.
   B. All insulation assembly shall meet thermal and fire rating requirements and shall be approved in writing by the roofing manufacturer.
   C. Insulation overlay shall be designed and suitable for the roofing material.

6. DRAINAGE
   A. Provide required slopes to drain in structure, unless otherwise approved by OSU Project Manager.
   B. Provide tapered insulation and crickets as required to achieve drainage requirements.
   C. Ballasted extruded polystyrene inverted insulation system shall meet FM and UP UL requirements.
   D. Install vapor retarder, as required, as part of the roofing assembly.

E. Fasten, adhere, stagger, offset to provide a proper base for roofing and to meet FM and UL requirements.
F. All fasteners shall be increased by 50% in number at all perimeter locations and at corners.
G. Insulation R-Value shall be 20% better than the requirement of the current Oregon Energy Code.

7. LOW SLOPE ROOFING
   A. Applied Locations
      01. Use on low slope concrete, steel, wood or insulated roof decks.
      02. Minimum ¼" per foot slope to maximum 1" per foot slope to drain. ½" per foot is preferred.
      03. Other slopes may be considered and approved by OSU's Project Manager, if necessary.
      04. Special securement may be required on slopes exceeding ½" per foot.
   B. Elastomeric Membrane Roofing:
      01. Use on low slope concrete, steel, wood or insulated roof decks, minimum ¼" per foot slope or as approved by OSU's project manager.
      02. Vapor Barrier:
      03. Substrate: Separation board, insulation system, overlay board assembly as required to meet Code/energy, wind uplift, fire rating, and manufacturer and OSU requirements as a suitable base for roofing.
      04. Material: EPDM (Ethylene Propylene Diene Monomer) fire rated 60 mils minimum thickness in largest sheets possible.
      05. Application: Fully adhered.
      06. Terminations: All perimeters and roof penetrations at vertical surfaces.
   C. Seams
      01. Protective Coating: Elastomeric as approved by membrane manufacturer.
   D. Standards
      01. NRCA Roofing and Waterproofing Manual – TS Series Specification Guides.
      02. ASTM – Standard Specifications for material Properties.
      03. UL – Fire Hazard Clarifications, Class A.
      04. FM – Roof Assembly Classifications – Class 1-90.
      05. OSSC, Chapter 15 – Roofing and Roof Structures.
      06. Approved Manufacturers: Siplast, Carlisle and Firestone or approved equal.
      07. Bituminous Membrane Roofing (preferred low slope roofing systems):

   E. Hot Asphalt Roofing
      01. Use of new hot asphalt roofing system is not allowed.

02. Major repairs for hot asphalt roofing systems – must plan and mitigate for odors entering air intakes and/or windows of the building being repaired and adjacent buildings as needed. University's representative to confer with EH&S on mitigation plan prior to work being commenced.

8. METAL ROOFING
   A. Applied Locations
      01. Use on low slope framing and steel or wood roof decks, minimum three inch (3") per foot slope.
   B. System: Sealed standing seams with concealed fastening and provision for expansion and contraction.
   C. Precoated Galvanized Steel: 24 gauge minimum core steel, G90 galvanized, Kynar coated.
   D. Underlayment: Rosin paper slip sheet, 30# asphalt saturated felt and rosin paper, self adhering underlayment, special underlayments when required by design or manufacturer's insulation system.
   E. Standards
      01. NRCA Roofing and Waterproofing Manual – Metal Roof Systems.
      02. ASTM D226 – Standard Specification for Asphalt Saturated Roofing Felt.
      03. ASTM B370 – Standard Specification for Copper Sheet and Strip.
      04. ASTM A361 – Standard Specification for Zinc Coated Steel Sheet.
      05. ASTM A308 – Standard Specification for Terne Coated Steel.
      06. ASTM C1167 – Standard Specification for Clay Tile.
      07. ASTM UL580 – Tested for Wind Uplift, Class 90 Rated.
      08. ASTMSMACNA Architectural Sheet Metal Manual.
   F. System
      01. Standing seams or approved design with concealed fastening system; provisions for expansion and contraction.
   G. Warranty:
      01. Provide 50-year Manufacturer's warranty
      02. Manufacturer's standard warranty for color

9. STEEP ROOFING
   A. Applied Locations
      01. Use on steep slope wood roof decks, minimum three inch (3") per foot pitch.
   B. Materials
      01. Shingles
         a. Self-sealing Architectural asphalt or SBS (Styrene-Butadiene-Styrene) modified bitumen, polyester/fiberglass or fiberglass reinforced, mineral granule surfacing, minimum 245# per 100 square feet, Certainteed Grand Manor or approved.

b. Shingle shall be moss protected and have minimum 50-year manufacturer's warranty.

02. Underlayment

a. 30# asphalt saturated roofing felt or breathable underlayment as approved by OSU's Project Manager
b. 1 layer for pitches of 4:12 and steeper,
c. 2 layers for pitches of 3:12 to 4:12, and
d. Self adhering underlayment for pitches less than 3:12.
e. Self adhering underlayment at all valleys, eaves and rakes.
f. Pitches of less than 4:12 are not recommended.

C. Standards

01. NRCA (National Roofing Contractors Association) Roofing and Waterproofing Manual – Application of Asphalt Shingles.
02. ASTM D226 – Standard Specification for Asphalt Saturated Roofing Felt.
03. ASTM D3462 – Standard Specification for Asphalt Shingles.

D. Warranty:

01. Manufacturer's standard 50 year material warranty
02. Manufacturer's standard warranty for color

E. Provide Code required ventilation under sheathing.

F. Insulation:

Insulation is not permitted directly below shingles.

01. Insulation to be designed and constructed to allow roofing material to function properly throughout warranty period.

10. FLASHING AND COUNTERFLASHING

A. Systems

01. Flashing and counterflashings, gutters and downspouts, copings, wall metal as required for the application.
02. Standing, water shedding, sealed and soldered seams as required for the application.
03. Expansion joints or other provisions for expansion as required.
04. Back metal with felt as required.

B. Materials: As required by application, compatible with roofing materials.

01. Metals

a. Precoated Galvanized Steel: 24 gauge minimum core steel, G90 galvanized, Kynar coated.
b. Terne Coated Carbon Steel: Gauge as required for application.
c. Terne Coated Stainless Steel: Thickness as required for application.
d. Stainless Steel: Thickness as required for application.
e. Copper: Sixteen (16) ounce minimum.
f. Lead: Four (4) pound.

02. Underlayment

03. 30# asphalt saturated roofing felt and rosin paper.
04. 15# where approved by OSU
05. Other breathable underlayment as approved by OSU and self adhering underlayment.

C. Warranty
01. Two-year installation warranty.

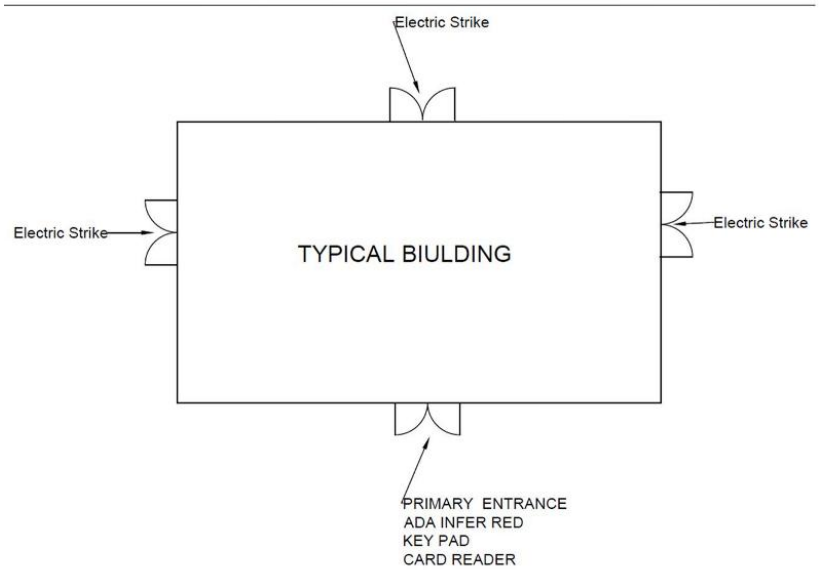
11. TIE-OFFS
A. Structures fours stories or greater shall be equipped with roof tie off systems that allow for routine window cleaning on those stories four stories or greater.

Section 08 05 00 – Common Work Results for Openings

PART 1 – GENERAL

1. REQUIREMENTS

A. All electronic access devices shall be Hirsch compatible.
B. All entry devices must be capable of being overridden by an Oregon State University Master Key.
C. All entrances shall be designed with appropriate air locks.
D. All entrances shall have a built in mat and/or dirt catch system.
E. All main entrances to new buildings or buildings that are significantly renovated shall include a fully automatic door at main entrance.
F. All other doors to new buildings shall be ADA accessible.
   01. The doors shall have proximity sensors placed at an accessible and appropriate location and centered 33 inches from the finished floor.
   02. All doors shall have levers and power assist if over 5 pounds force is necessary to open
   03. Door operating hardware shall be in an easily and fully accessible location.
G. University Housing & Dining Services has a separate specification for door operating hardware for its facilities. Design teams are to incorporate the UHDS specifications for work on UHDS facilities. The UHDS specification is available by contacting Dan Larson, Associate Director for University Housing & Dining Services at 102 Buxton Hall, by phone at 541-737-0683 and email at dan.larson@oregonstate.edu.



Section 08 31 00 – ACCESS PANELS

PART 1 - GENERAL

1. REQUIREMENTS
   A. Provide access panels in non-accessible ceilings wherever there is equipment or a device that needs maintenance (valves, dampers, junction boxes, terminal units, etc.).
   B. Access panel sizes shall be sized to accommodate the largest piece of equipment. The location of access panels shall be reviewed by the Project Manager and PRT to ensure the location is accessible for maintenance and operation requirements.
      01. Access panel shall be, at a minimum 12” x 12” where the equipment or device is less than 18” from the finished ceiling.
      02. Use 24” x 24” access panels where the equipment or device is more than 18” from the finish ceiling and where equipment or device has a panel or door that needs to be opened or removed for service.
      03. Use a minimum of 8” x 8” access panels in walls to access valves or other appurtenances.
   C. Locate access panels directly under or in front of the equipment or device.
   D. Final location of access panel shall be determined on site by project manager and EHS construction safety officer prior to installation.

Section 08 50 00 – WINDOWS

PART 1 - GENERAL

1. REQUIREMENTS
   A. Windows must meet the Oregon State Energy Code requirements and the requirements of the State Energy Efficiency Design model for the building.
   B. All windows to be Tinted low "E" glass.
   C. All Window frames shall have a thermal break.
   D. No wire-glass windows are permitted.
   E. All window glass/glazing should have 5-year warranty.
   F. To prevent energy waste, all spaces with operable windows must have window-HVAC interlock to prevent HVAC system operation with windows open.

Section 08 71 00 – Door Hardware

PART 1 – GENERAL

1. REQUIREMENTS
   - A. Any key locking devices e.g., programmers, interrogators, junction boxes, etc must be capable of accepting an OSU – supplied lock.
   - B. The main entry of each new building must be equipped with a Knox box for emergency access by the Corvallis Fire Department.
     - 01. For renovation projects the OSU Project Manager is responsible for contacting the City of Corvallis Fire Marshal to determine of the installation of a Knox box is required.
   - C. All exit devices shall be approved by the OSU Key Shop prior to installation.
   - D. Fully automatic doors for main entrance, ADA accessible doors for all other doors should have proximity sensors placed at an accessibly appropriate location and centered 33 inches above finished floor surface.
   - E. All new hardware shall be supplied with Best cylinders.
   - F. OSU Key Shop shall provide pinning for lock cylinders.
   - G. For all remodel projects the existing hardware shall be matched with existing building hardware unless that hardware is no longer available. If unavailable refer to the OSU Key Shop.
     - 01. All SCHLAGE cylindrical lock-sets shall be "93K" (“14D”Lever) series. (ADA)

2. EQUIPMENT
   - A. Electric Strikes with Key Override
     - 01. Electric strikes shall provide remote release of latch-bolts.
     - 02. Electric strikes shall be designed for use with the type of locks shown at each opening where required.
     - 03. Electric strikes shall be UL Listed as Burglary-Resistant Electric Door Strikes and where required shall be UL Listed as Electric Strikes for Fire Doors or Frames.
     - 04. Faceplates shall be stainless steel with finish, as specified for each opening.
     - 05. The locking components shall be stainless steel to resist damage and abuse.
     - 06. Solenoids shall be of the continuous duty type for the voltage specified. Plug connectors will be furnished.
     - 07. Strikes shall have an adjustable back-box to compensate for misalignment of door and frame.

08. Strikes must meet (or exceed) ANSI 156.5 and must fit within (a slightly modified) standard ANSI 115.2 cutout.

B. Electro-magnetic Locks
   01. All electro-magnetic locks must have a key override set to the OSU system.
   02. Must be manufactured by Von Duprin Inc., or Hess.
   03. Electromagnetic lock enclosure must be surface applied.
   04. Lock must be low voltage, 12V-24V dual coil with a tested hold force of no less than 1,800 pounds.
   05. Electromagnetic lock must have built-in, as standard, electronics to eliminate residual magnetism and also to provide transient suppression.
      a. Build these devices into doors, jambs, and/or door closers. The controls for electromagnetic holders shall work in conjunction with fire detection to provide fire/smoke barriers by an automatic door closing.

C. Exit Devices
   01. Any mechanical emergency exit device (crash bar) must meet (or exceed) ANSI A156.3, 1984 Grade 1 or match original historic hardware. For questions see OSU Key Shop.
   02. Ensure minimum ADA clearances with door in open position.

D. Lock-sets
   01. If mortise lock-sets are specified they shall be supplied with BEST 7 PIN CYLINDERS, regardless of the lock manufacturer.
   02. If cylindrical lock-sets are specified, they shall be BEST "93K7" series lever handle lock-sets prepared to receive BEST 7 pin REMOVABLE cores.
   03. Lock functions – Series Numbers
      a. Classroom
         1. Schlage ND94PD-SPA
         2. Best 93K7R14KS3
      b. Communicating
         1. Schlage ND62PD-SPA
         2. Best 93K7S14KS3
      c. Dormitory
         1. Schlage ND73PD-SPA
         2. Best 93K7T14KS3
      d. Double Fixed
         1. Schlage ND82PD-SPA
         2. Best 93K7W14KS3

e. Passage
1. Schlage ND10S-SPA
2. Best 93K7N14KS3

f. Privacy
1. Schlage ND40S-SPA
2. Best 93K7N14KS3

g. Store
1. Schlage ND66PD-SPA
2. Best 93K7G14KS3

h. Storeroom
1. Schlage ND96PD-SPA
2. Best 93K7D14KS3

i. Twist-push
1. Schlage ND53PD-SPA
2. Best 93K7B14KS3

j. Vestibule
1. Schlage ND60PD-SPA
2. Best 93K7C14KS3

04. Best Cylinders
a. Rim Cylinder – Part # 1E-72
b. Mortise Cylinder – Part # 1E-74
c. Dummy Rim – Part # 1E-02

05. Standard Hardware Finishes
a. Satin Bronze – 612 (US10)
b. Oil-rubbed Bronze – 613 (US10B)
c. Satin Chrome – 626 (US26D) – Part # 1E-72
d. Mortise Cylinder – Part # 1E-74
e. Dummy Rim – Part # 1E-02
f. Dummy Mortise – Part # 1E-04

E. Door Closers
01. LCN LC-4041 Super Smoothee Heavy Duty Door Closer.
02. Panic hardware shall be Von Duprin 99 series.

F. Automatic Door Operators
01. LCN 41820 Series
02. Horton 7100
03. Besam SW100

G. Automatic Door Actuator Sensors
01. MS Sedco #216 Touchless Switch

H. Access Cards

01. Camden CX-WC1 Restroom Control Kit
02. Substitute Camden CM-500/4 Mushroom Push Switch for switch provided in kit.
03. Provide Von Duprin 6210 electric strike.

Section 09 51 00 – ACOUSTICAL CEILINGS

PART 1 – GENERAL

1. REQUIREMENTS
   - A. Commercial grade ceiling assembly meeting current Oregon adopted IBC Standards.
   - B. All supporting components must be certified as UL approved.
   - C. Light fixtures, ceiling mounted diffusers (or grills) and other openings in the ceiling must be supported in compliance with Oregon current IBC Standards 25-2.
   - D. Supply & install Armstrong No. 895, 2' X 4' ceiling panels as standard. Armstrong Prelude XL Fire Guard 15/16” is approved by ICBO.
   - E. T-bar ceilings shall be full size T’s - need to be 15/16” grid heavy duty.

Section 09 60 00 – FLOOR COVERINGS

PART 1 – GENERAL

1. REQUIREMENTS
   - A. All floor coverings must be asbestos free.
   - B. Material that is manufactured overseas shall be certified to be asbestos free prior to delivery. Low VOC adhesives shall be used for flooring installation. Concrete sealer shall be applied to slab on grade concrete if modular carpet or tile will be applied on top of it.
   - C. Indoor hallways, classrooms, elevators, dining rooms -- vinyl tile or linoleum (Marmoleum preferred) flooring. Restrooms -- Ceramic or seamless flooring. Modular carpet is acceptable in classrooms needing acoustic dampening.
   - D. Resilient Flooring: Chemical-use laboratories, glass wash or other areas where liquids are used or stored shall have watertight flooring. Provide seam sealed sheet vinyl or linoleum flooring or equivalent with at least a 4-inch continuous cove. Flooring material to be compatible with the chemicals or other materials to be used or stored and to be a tested and recognized flooring material for the anticipated use.
   - E. Modular carpet (carpet tiles) should be used. No wall-to-wall carpet shall be installed. The number of transitions from hard to soft flooring shall be minimized. Avoid installing carpet on concrete below grade or on basement floors.
   - F. Color will be determined on a case by case basis; however, attempts should be made to coordinate the existing color scheme. Extra materials overage of 2-5% will be provided. Materials should require minimum maintenance and should comply with industry cleaning standards methods.
   - G. No raised flooring floor coverings.
   - H. Underlayment: Follow the requirements of the Armstrong Guaranteed Installation Systems Guide, latest edition, where wood underlayment is required under carpet, vinyl tile, or sheet goods.
   - I. Polished or stained concrete in public areas shall be considered.
   - J. Flooring choices must take into consideration traction and slip-resistant properties to minimize incidents.

Section 09 90 00 – PAINTS AND COATINGS

PART 1 – GENERAL

1. REQUIREMENTS
   - A. Plans shall designate color and sheen to be used.
   - B. Coat/seal all items prior to installation as much as able; special consideration(s) required in occupied buildings. At pre-construction meeting define plans to reduce impact to building users regarding application of finishes, paints, adhesives, etc.
   - C. Paints should be selected for maximum durability (infrequent repainting) and minimum environmental and human impact for the given application. Consider ventilation, exposure to physical damage, vandalism potential, liquids, likely maintenance frequency, etc.
   - D. Water based finishes only for interior and onsite applications.
   - E. The following paint manufacturers are acceptable:
     - 01. Benjamin Moore
     - 02. Flecto (UHDS)
     - 03. Miller
     - 04. Pittsburgh
     - 05. Rust-Oleum
     - 06. Sherwin-Williams
   - F. OSHA Safety Colors:
     - 01. All colors should conform to OSHA and ANSI specifications and are available in IronClad Quick Dry Industrial Enamel (071).
   - G. Low VOC materials are to be used; zero VOC when available. Paint containing 5 grams/liter or less is considered "Zero VOC", according to the EPA Reference Test Method 24. On new construction or major remodels, follow applicable LEED criteria for low or zero VOC paint.
   - H. The finish manufacturer’s recommendations for acceptable moisture ranges prior to application / installation shall be followed. Moisture testing on concrete, substrate, etc. is required prior to installation of finishes and results must be submitted to the Facilities PM.
   - I. Covering or painting of any signs, labels, identification, etc. requires replacement.

2. APPROPRIATE PAINT APPLICATION BY AREA
   - A. Interior surfaces
     - 01. OSU requires ceilings and walls in general purpose areas (offices, classrooms, conference rooms, break rooms, lobbies, hallways, etc) to receive low or zero VOC paint.

02. Doors, door frames, hand rails, corner trim, floors, certain lab surfaces and other areas exposed to high or frequent impact may receive higher durability products. These products may or may not be low or zero VOC.

B. Exterior surfaces
   01. Exterior surfaces should be painted with products appropriate for the substrate and exposure to weather, vandalism, graffiti and other elements.
   02. Minimum 15 year durability paint on all exterior surfaces. Acceptable paints include Benjamin Moore MoorGard; Miller Evolution-exterior; and Sherman Williams Duration.
   03. Exterior metal accessories and/or furnishings shall be galvanized or powder coated; no painted finish.
      a. Galvanized when accessories are poured in place and/or not removable for refinishing.
      b. Powder coated when accessories are removable for refinishing.

C. Pavement Markings
   01. Pavement markings that are painted on parking lot or road surfaces shall be applied using:
      a. Sherwin Williams, Setfast Waterborne pavement marking paint.
      b. Touchups and small applications can be made using Sherwin Williams SherLiner solvent based aerosol inverted spray cans.
   02. Thermal Pavement Markings
      a. Thermal (melt down) pavement markings are supplied be either 3M or Flint Trading INC and are applied according to manufacturer's specifications.

Section 10 14 00 – SIGNAGE

PART 1 – GENERAL

1. REQUIREMENTS
   - A. OSU has an interior sign system that is consistent with all new and remodeled campus buildings constructed since 1991.
   - B. This sign system is manufactured by Innerface Architectural Sign Systems; 5320 Webb Parkway; Lilburn, GA 30047, Phone (800) 445-4796, FAX (770) 279-1327. The signs are a vandal resistant system, meet existing ADA regulations and OSU requirements for graphic clarity. Sign colors are left up to the building design team, however the size, shape and style will remain consistent with other interior building signage. Similar signs from their companies may be substituted.
   - C. The use of self-luminous exit signs containing radioactive material is prohibited unless specifically approved by Environmental Health & Safety (EH&S).
   - D. All signage will follow the ADA Accessibility Guidelines for Buildings and Facilities (ADAAG) section 4.30.

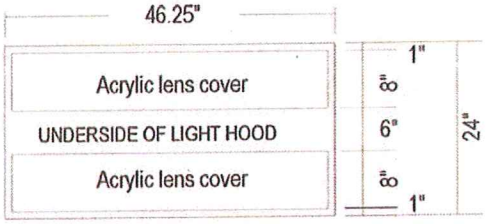
2. TYPES OF SIGNS
   - A. Room Hazard Signage
     - 01. Utilize Module 8.11 (wall mount) to accommodate an 8.5” x 11” insert; inserts to be provided by Environmental Health & Safety (EH & S).
     - 02. Signs to be mounted at each room entrance
     - 03. Signs to be 49” high (to sign bottom) on door knob side and below room number signage
   - B. Emergency Evacuation Sign
     - 01. All campus buildings over one story high shall have building evacuation signs posted on every floor. The signs shall be posted at all stairway and elevator landings and immediately inside all public entrances to the building. The insert for the holder shall conform to the following criteria to comply with state regulations:
       - a. Show floor plan for the level on which it is placed. Should be easy to see immediately by someone entering that floor of the building.
       - b. Place signs no more than 4 feet above finished floor.
       - c. Make sign’s lettering at least 3/16 inch high in a sans-serif font. The words shall be in sharp contrast to the background and easy to read.
       - d. Include emergency procedure information for the physically disabled.
       - e. Indicate the locations of exits and fire alarm pull stations.
       - f. If there are elevators on the floor, state they are not to be used during emergencies.

g. Other pertinent information may be added to the sign, such as location of fire extinguishers, hazardous material spill kits or emergency preparedness equipment.

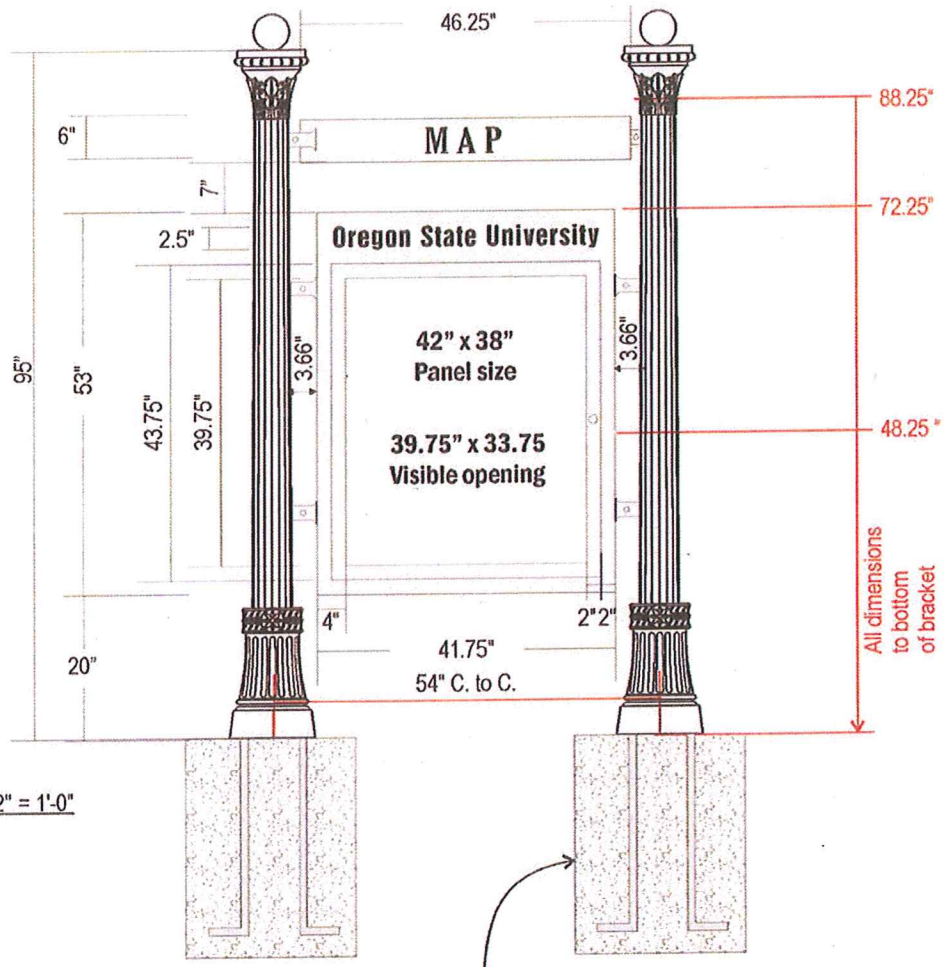
Section 10 18 00 – INFORMATION KIOSKS

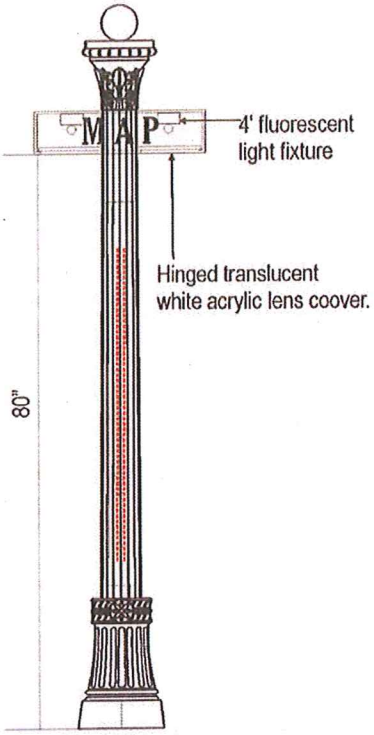
PART 1 – REQUIREMENTS

1. Kiosks
    A. OSU Welcoming Kiosk
        01. Custom cabinet, steel posts, map panels, down lighting, and appurtenances per ES&A's copyright design
        02. Available at Eugene Sign & Awning Company, 89975 Prairie Road, Eugene, OR 97402
    B. See attached drawing



Section view





1/2" = 1'-0"

Install using j-bolts provided with steel posts.
Directly bury in concrete footings.

CAUTION: The design concept, ideas, and specifications contained herein are the intellectual property of ES&A Sign Corp., for a project that has been custom designed, planned, and submitted for your approval. No element of the design concept shall be copied, disclosed, or provided in any form to any other person or entity without the express written permission of ES&A Sign Corp. By accepting this submission, you further agree that no element of the design will be implemented by any other person or entity other than ES&A Sign Corp. without the express written permission of ES&A Sign Corp. In the event design elements or concept drawings are disclosed to any other person or entity, ES&A Sign Corp. may pursue any legal remedies including, but not limited to, court action, in which the prevailing party shall be entitled to attorney fees and costs.
GRAPHIC PRESENTATION ONLY. PLEASE SEE YOUR REPRESENTATIVE FOR ACTUAL COLOR AND MATERIAL SAMPLES.
VARIOUS PRINTERS & MONITORS WILL INTERPRET COLORS IN DIFFERENT TONES & SHADES.

PRESENTATION FOR:
OSU
CORVALLIS, OREGON

DRAWING#: OSU MAP SIGN

89975 PRAIRIE RD.
EUGENE, OR 97402
P | 541.485.5546
F | 541.485.5813
WWW.ESASIGNS.COM

ES&A SIGN & AWNING CO.

Section 10 28 16 – BATHROOM ACCESSORIES

PART 1 – GENERAL

1. REQUIREMENTS
   - A. Floor drain.
   - B. Ceramic or Seamless floor.
   - C. Keyed hot water hose bib under sink.
   - D. Wall-mounted partitions, preferred.
   - E. Isolation valves.
   - F. Architect to show location, elevations, and correct size of bathroom accessories on plans.
   - G. Built-in dispensers will not be allowed

2. BATHROOM EQUIPMENT (to be supplied by Facilities Services or Contracted Service Provider as appropriate):
   - A. Toilet seat cover dispenser, white #710 ½ fold.
   - B. Paper towel dispenser, single-fold -- Fort Howard 567-01.
   - C. Dispenser, soap – GJ5150; special order (3 week lead time) through Coastwide (541-926-3289).
   - D. Roll towel dispenser, -- Fort Howard 565-53.
   - E. Tampon dispenser, RT 30, HST 25v.
   - F. Dispenser, sanitary 8” pad, NSIE #8-H.
   - G. Sanitary can – garbage step-on lid, white, plastic liner.
   - H. Toilet paper dispenser, roll – GP53771; special order (3 week lead time) through Coastwide (541-926-3289).
   - I. Electric hand drying equipment
     - 01. Operation
       - a. No heating element, high velocity air (aka motor heated)
       - b. Touch free activation via infrared sensor
       - c. 15 seconds or faster drying time
       - d. 85 dB or lower sound level
       - e. Optional air filtration provided at OSU’s request
     - 02. Electrical
       - a. 1400 watts or lower operating power consumption
       - b. 110-120V, 208-240V or 220-240V compatibility, depending on application
       - c. Standby power consumption of 2 watts or lower
     - 03. Construction
       - a. Housing should minimize maintenance needs and retain clean appearance under low maintenance conditions. Acceptable

housing materials include ABS plastic, stainless steel and aluminum

b. Format must support ADA-compliant installation

04. Warrantee minimums: 5 year parts, 1 year labor

Section 11 53 13 – FUME HOODS

PART 1 – GENERAL

1. REQUIREMENTS FOR RENOVATION
   A. Building-wide
      01. Each hood or local exhaust system used to control exposure of humans to hazardous chemicals, radioactive materials, or other detrimental materials must be approved at the pre-design phase and after installation by Environmental Health & Safety (EH&S).
      02. Hoods shall be of the latest design, good quality, and produced by a reputable manufacturer. A list of acceptable hood models is maintained by EH&S.
      03. Auxiliary air hoods that have the makeup air supplied at the hood face shall not be used.
      04. Ductless hoods shall not be used for protection against chemical or radioactive materials.
      05. Hood shall be constructed of appropriate materials resistant to chemicals and heat, and compatible with the anticipated use.
      06. Exhaust velocity at the hood face will be DESIGNED to 120 linear feet per minute (LFPM) at a sash height of 18 inches above the lower air foil.
      07. Exhaust velocity at the hood face will be a minimum of 100 LFPM at a sash height of 15 inches above the lower air foil.
      08. Each hood must have an electronic flow indicator with digital readout that is visible to the hood user. Monitor type must allow for two-point calibration without changing hood flow. Calibration of the flow monitor will be performed during room balancing.
      09. Hood exhaust shall be separate from non-lab building exhaust systems. Hood exhaust can be used as part of the required lab exhaust volume.
      10. Hoods used for perchloric acid, high levels of radioactive isotopes, high hazard carcinogens, pathological materials, or large quantities of flammable liquids shall be exhausted separately from general laboratory fume hoods.
      11. Hood exhaust ducts shall be negatively pressurized within the building.
      12. No diversion caps (e.g., “china hat”) are allowed on hood stacks. Rain prevention extensions shall be used where rain intrusion is a potential problem. Design details are available from EH&S.
      13. Booster exhaust fans in hood exhaust ducts shall not be used inside the building envelope.
      14. Backflow prevention devices shall not be installed in ducts as the only means to prevent reverse airflow.
      15. Hood filters will not be used unless absolutely required.
      16. Filter boxes will be located to allow safe and efficient access for filter change, and design will allow for safe bag-in/bag-out procedures.

17. An adjustable gate damper must be provided in the individual branch duct serving each hood. It should be located such that the hood user cannot easily change the setting.
18. Room balance and room-to-room balance shall be maintained throughout operating range of hoods.
19. Outside air supply will be adjusted relative to exhaust air to make up for hood exhaust.
20. When there are multiple hoods in a building use make-up and heat recovery systems and/or variable volume exhaust systems, where practicable, to maintain energy efficiency.
21. A building-wide system shall monitor and control building static air pressure.
22. Hood interior lighting is to be uniform within the work cavity, as available from manufacturer.
23. Light fixtures to be accessible and maintainable externally to the hood cavity.
24. Light fixture type is to be T-8 energy efficient fluorescent type with electronic ballast.
25. A label on each fan unit will identify all room numbers of fume hoods served. A separate label, applied on primary side of approach, will be provided with the wording “Caution – Fume Hood Exhaust”.
26. Identification labels are to be indelible, non-fading and installed on the north side of exterior housings whenever possible.
27. Fume exhaust ductwork
    a. Ducts conveying corrosive air streams must be designed with materials compatible with use. The type of ductwork to be used is subject to OSU project review team assessment.
    b. Design for maximum pressures developed by the exhaust system with a 25% safety factor.
    c. See the systems below for a partial list of recommendations;
        1. Heat Exhaust - Galvanized steel
        2. Laboratory Equipment Exhaust
            1.A.01.c.2.1 Acid Exhaust - Stainless steel to the fan
            1.A.01.c.2.2 Solvent Exhaust - Stainless steel to the fan

Section 11 53 53 – BIOLOGICAL SAFETY CABINETS

PART 1 – GENERAL

1. REQUIREMENTS
   - A. All biological safety cabinets shall meet the specifications within the most recent edition of the National Sanitation Standard 49 – Class II (Laminar Flow) Biohazard Cabinetry.
   - B. The following biological safety cabinet manufacturers are currently approved for campus:
     - 01. Baker, Nu-Aire, and Forma or equal. Manufacturer's specifications for specific model types shall be submitted to OSU EH&S for pre-approval. The University's Representative (Project Manager) must acquire pre-approval from OSU EH&S for any "equal" substitution.
     - 02. Biosafety cabinet face velocity shall be maintained at no less than 100 fpm at all times during operation.
     - 03. Each cabinet shall be equipped with one front mounted magnahelic gauge indicating the differential pressure across the filter.
     - 04. The noise level as measured 12 inches in front of the cabinet and 15 inches above the work surface shall not exceed 67 dBA.
     - 05. All biosafety cabinets must be tested per National Sanitation Foundation (NSF) Standard 49 or manufacturer's specifications after installation. The University's Representative should forward the testing results to OSU EH&S for review.
   - C. Class II Type B biosafety cabinets must be installed on a dedicated stainless steel exhaust system.
   - D. Exhaust in-place HEPA filters must be of the bag-in/bag-out type, and installed to allow for safe and efficient filter change.

2. CLASSES AND TYPES OF BIOLOGICAL SAFETY CABINETS
   - A. Class II Type A1 cabinets (formerly designated Type A)
     - 01. Maintain minimum average inflow velocity of 100 fpm (0.5 m/s) through the work access opening;
     - 02. Have HEPA filtered downflow air that is a portion of the mixed downflow and inflow air from a common plenum (i.e., a plenum from which a portion of the air is exhausted from the cabinet and the remainder supplied to the work area);
     - 03. May exhaust HEPA filtered air back into the laboratory or to the external environment through an exhaust canopy; and
     - 04. May have positive pressure contaminated ducts and plenums that are not surrounded by negative pressure plenums.
     - 05. Type A1 cabinets are not suitable for work with volatile toxic chemicals and volatile radionuclides.

B. Class II, Type A2 Cabinets (formerly designated Type B3)
   01. Maintain a minimum average inflow velocity of 100 fpm (0.5 m/s) through the work access opening;
   02. Have HEPA filtered downflow air that is a portion of the mixed downflow and inflow air from a common exhaust plenum;
   03. May exhaust HEPA filtered air back into the laboratory or to the environment through an exhaust canopy; and
   04. Have all biologically contaminated ducts and plenums under negative pressure or surrounded by negative pressure ducts and plenums.
   05. Type A2 cabinets used for work with minute quantities of volatile toxic chemicals and tracer amounts of radionuclides required as an adjunct to microbiological studies must be exhausted through properly functioning exhaust canopies to the exterior.

C. Class II, Type B1 Cabinets
   01. Maintain a minimum average inflow velocity of 100 fpm (0.5 m/s) through the work access opening;
   02. Have HEPA filtered downflow air composed largely of uncontaminated recirculated inflow air;
   03. Exhaust most of the contaminated downflow air through a dedicated duct exhausted to the external atmosphere after passing through a HEPA filter; and
   04. Have all biologically contaminated ducts and plenums under negative pressure or surrounded by negative pressure ducts and plenums.
   05. Type B1 cabinets may be used for work treated with minute quantities of volatile toxic chemicals and tracer amounts of radionuclides required as an adjunct to microbiological studies if work is done in the direct exhausted portion of the cabinet, or if the chemicals or radionuclides will not interfere with the work when recirculated in the downflow air.

D. Class II, Type B2 Cabinets (sometimes referred to as “total exhaust”)
   01. Maintain a minimum average inflow velocity of 100 fpm (0.5 m/s) through the work access opening;
   02. Have HEPA filtered downflow air drawn from the laboratory or the outside air (i.e., downflow air is not recirculated from the cabinet exhaust air);
   03. Exhaust all inflow and downflow air into the external atmosphere after filtration through a HEPA filter without recirculation in the cabinet or return to the laboratory; and
   04. Have all contaminated ducts and plenums under negative pressure or surrounded by directly exhausted (nonrecirculated through the work area) negative pressure ducts and plenums.
   05. Type B2 cabinets may be used for work with volatile toxic chemicals and radionuclides required as adjuncts to microbiological studies.

E. Class III Cabinets (Glove Boxes)

01. A totally enclosed, ventilated cabinet of leak-tight construction. Operations in the cabinet are conducted through attached rubber gloves. The cabinet is maintained under negative air pressure of at least 0.50 in. w.g. (120 Pa). Downflow air is drawn into the cabinet through HEPA filters. The exhaust air is treated by double HEPA filtration or by HEPA filtration and incineration.
02. A glove box may also be required for special applications using highly toxic, extremely reactive or regulated carcinogens.
03. Glove boxes shall meet ANSI standard Z9.5, "Standard on Lab Ventilation" and the American Glove Box Society Standard, "Guidelines for Glove Boxes".
04. Reactive chemical work may require a glove box positively pressurized with inert atmosphere during reactions.

3. SPECIALTY HOODS AND LOCAL EXHAUST/SNORKEL HOODS
   A. General
      01. Histology hoods, specimen, welding and other local exhaust specialty hoods require a minimum operating face velocity of 100 fpm with a range of 100-120 fpm. Higher values may be required based on setup. Design will be coordinated with EHS.
      02. An audible/visual flow alarm may be required depending on intended use.
   B. Placement
      01. Locate biological safety cabinets at least six feet from doors and high-traffic areas and away from open-able windows, fume hoods, or other draft producing laboratory equipment. Locate so that air supply/exhaust diffusers do not affect airflow at the BSC face (laminar diffusers preferred). If more than one BSC will be installed, situate BSCs across from each other rather than adjacent.
      02. Provide at least 12 inches of clearance above the BSC for testing and decontamination of HEPA filters. Set six inches out from the rear wall to allow for cleaning and adequate air return.
      03. Biological safety cabinets that are hard-ducted or connected by a thimble connection to the ventilation system must be designed so the duct work does not interfere with air flow or block access to the exhaust filter for testing of HEPA filter integrity.

Section 12 56 33 – CLASSROOM FURNISHINGS

PART 1 – GENERAL

1. REQUIREMENTS
   A. Stationary workstations in the office/laboratory setting should provide adequate surfaces for ergonomic arrangement of the computer keyboard/pointing device, monitor, and document/work holders.
   B. Stationary workstations shall follow good ergonomic principals providing height adjustable work surfaces, openings adequate for leg and knee clearances and sufficient overhead space to allow adjustments to vertical equipment placement.
   C. Workstations shall follow the design features found in the following documents:
      01. Oregon Department of Administrative Services, Risk Management Division – "Ergonomic Consensus Guidelines".
      02. ANSI/Human Factors and Ergonomics Society (HFES) 100 – 2007 (or most current version) - "Human Factors Engineering of Computer Workstations."
   D. Where feasible, adjustable keyboard trays shall be of a one piece, uni-board design, adjustable for height and angle, and possess an angle adjustment knob that does not interfere with leg movement. Recommend utilizing the Humanscale model 500 Big Board or equivalent.
   E. Ergonomic chairs/stools in the laboratory environment shall be constructed of durable, smooth, and easily cleanable materials.

Section 12 90 01 – FLAMMABLE AND CORROSIVE STORAGE CABINETS

PART 1 – GENERAL

1. REQUIREMENTS
   A. Flammable storage cabinets must be UL listed and/or NFPA approved.
   B. Flammable storage cabinets are not required to be ventilated. If cabinet is to be vented, it must be ducted into the fume hood exhaust system above the fume hood trim damper. Ducting material must be nominal 2” black pipe.
   C. Corrosive chemical storage cabinets (acids and bases) require venting. It is acceptable to vent under-hood corrosive cabinets into hood interior through the countertop. Ducting material shall be schedule to PVC.

Section 12 93 00 – SITE FURNISHINGS

PART 1 - GENERAL

1. REQUIREMENTS
   A. The products identified herein are the preferred products for placement on OSU campus. Substitutions may be made provided the vendor, contractor, designer, etc receives written approval from the Campus Planning Manager for the suggested substitution.
   B. The paint color for all furnishing, regardless if substitution is granted, is to be:
      01. OSU Black – Paint: Benjamin Moore #80; 50% gloss. Powder coat: Cardinal BK78 Black.
      02. OSU Orange – PPG # 90-313 – "Safety Orange".
   C. The approved list for site furnishings is included in Section 12550.
   D. Cast in place retaining walls/seat walls and benches must be chamfered with grooves, for sufficient depth installed on all edges, to deter skateboards.
      01. Continuous surface/edge without skate deterrent must not exceed 4'.
   E. For monument signs refer to Section 32250.
   F. All site furnishings will be designed with an appropriately engineered footing, where required.
   G. At a minimum there shall be a trash receptacle and recycling bin at every entry to the building.

2. EXTERIOR SIGNAGE
   Oregon State University requires an effective system of visual communication that projects a uniform institutional identity, while at the same time integrating well with the present and future campus environment. The following requirements identify how exterior signage will be applied to the OSU main campus.
   A. Monument signs are considered the main building identification and will only include building name, abbreviation and street address.
      01. Minimum setback for primary identification signs from the curb face shall be two (2) feet.
      02. Minimum separation between primary identification signs shall be 100 feet.
   B. Directional Signs provide direction to parking lots, buildings, and athletic and/or event facilities within a specific location and include the following requirements:
      01. Minimum clearance for these signs located above a pedestrian walkway shall be 10 feet. If a directional sign is attached (such as building, light post, etc.):
         a) If the attached sign projects more than 6 inches, the minimum clearance above a pedestrian walkway shall be 7 1/2 feet;

b) If the attached sign projects more than 1 foot, the edge of the sign face closest to the building shall not project more than 6 inches;

c) No attached sign shall project more than 8 feet from the building face.

02. No direction signs are to be attached to any historic building. (Refer to the OSU Historic Preservation Plan Design Guidelines.) This includes ADA signage providing direction to access entrances.

C. Banners must be mounted on dual arms to a campus light pole.

D. Exterior signs within the historic district must comply with City of Corvallis Land Development Code Chapter 2.9 – Historic Resources. Installation of exterior signs within the historic district to be coordinated with Campus Planning.

Section 12 93 01 – APPROVED SITE FURNISHINGS LIST

PART 1 – GENERAL

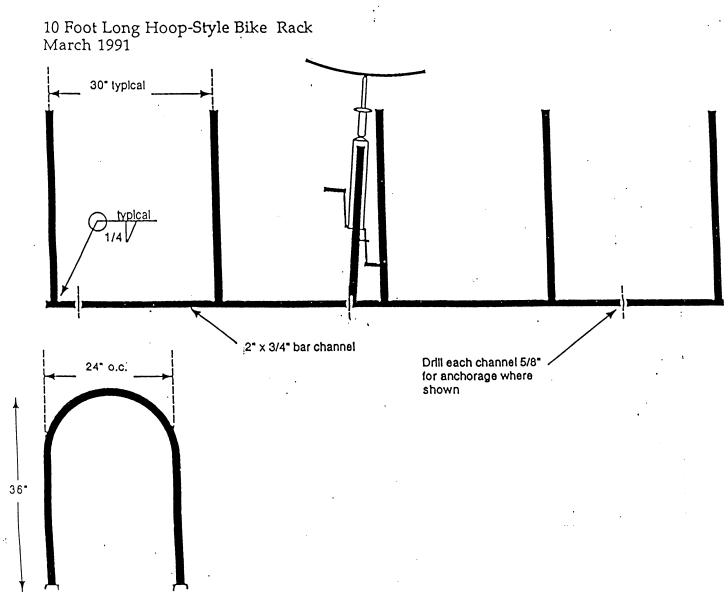
This list represents the approved models for site furnishings that may be placed on the OSU campus.

A. Trash Receptacles: RPB, McKenzie trash receptacle, powder coated black. Available from Radius Pipe Bending (www.radiuspipe.com).

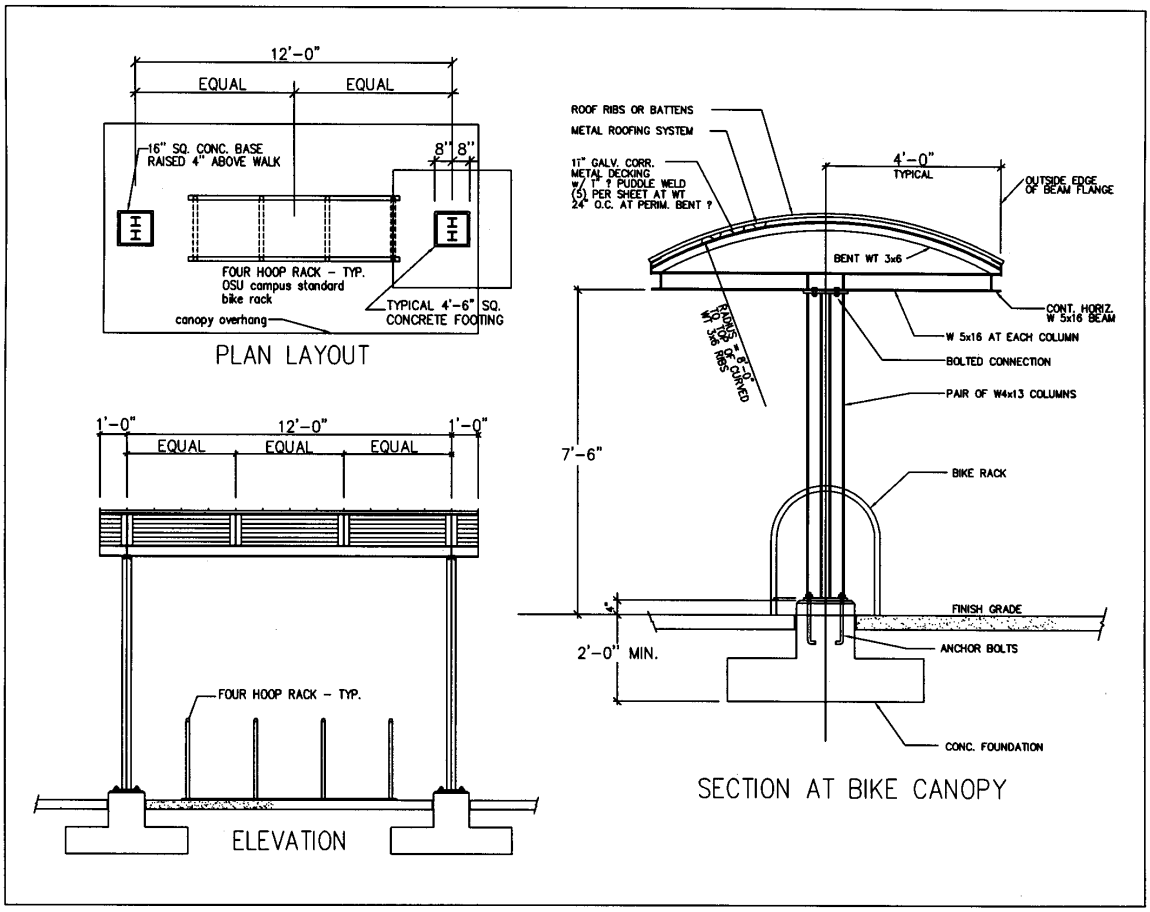
B. Ash Urns:RPB, McKenzie smoking urn, powder coated black. Available from Radius Pipe Bending (www.radiuspipe.com).

C. Benches:
   01. Campus Standard Bench
      a. Dumor Site Furnishings, Model 58. 6-foot, powder-coated steel, color: black; www.dumor.com/benches; 800-598-4018.
   02. Accessible Bench
      a. DuMor Site Furnishings, Model 68-452 (custom OSU accessible bench). 6-foot, powder-coated steel, color: black.

D. Bicycle Racks
   01. OSU Campus Standard Bike Racks
      a. Various length, depending on number of hoops (2-5 hoops available) Hoop-Style, tubular steel Bike Rack. Black powder coated finish; non-powder coat steel requires frequent painting of racks. Installation of 5- hoop racks is encouraged to provide flexibility in relocation.
      b. Available at Radius Pipe Bending Co.; Prairie Road, Junction City, OR 97448.
      c. All racks to be welded to 2” channel iron base rails. Embedded racks are prohibited.
      d. Specification:



E. Covered Bicycle Racks



01. Signpost: A Unistrut Telespar Quick punch 2” 14 gauge square tubing with two 1/4” x 24” 12 gauge perforated galvanized anchor tubing. The anchor shall not extend more than 4” 2", (2” anchor left exposed per manufacturers installation recommendation for both single and double breakaway anchors) above finish grade.

F. Street Signage

01. OSU Campus Standard Post: 2” x 2” x 10’, 14 gauge, galvanized steel, quick punch, painted OSU standard site furnishing colors.

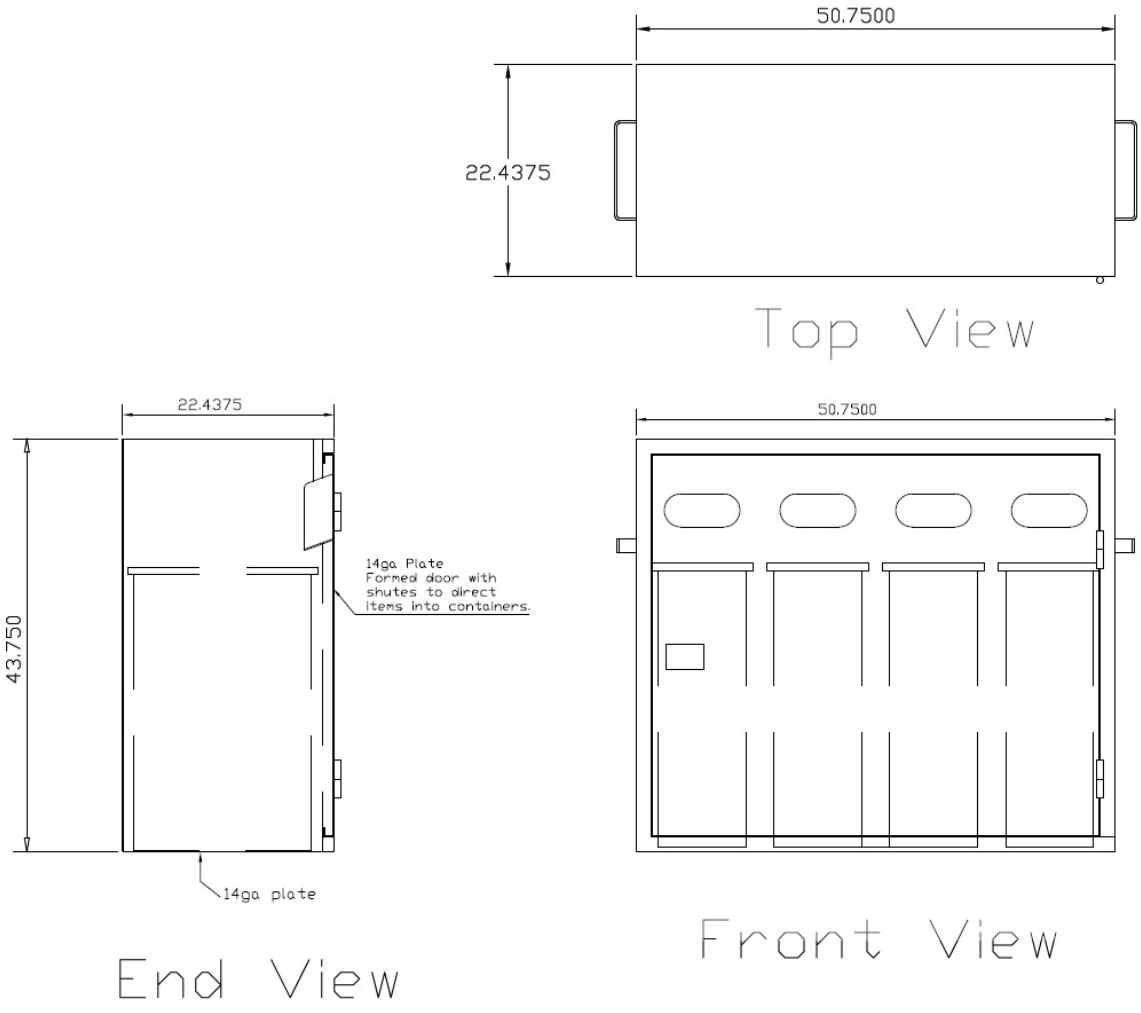
G. Monument Sign

01. There are (3) sizes for OSU Monument signs. The size of the sign is determined by its location in proximity to the OSU campus boundary as defined by the OSU Campus Master Plan.
02. Monument Signs outside the OSU Boundary: These signs will be visual vehicular traffic where speed may exceed 50 miles per hour. Prior to sign construction a sign permit must be submitted to the City of Corvallis for approval.
03. Monument Signs within the OSU Boundary: These signs are within the OSU campus boundary, but outside of Sector C as identified in the OSU Campus Master Plan. The City of Corvallis’ Land Development Code identifies an OSU sign exemption boundary, and monument signs within the OSU boundary may fall outside of the City of Corvallis OSU Sign Exemption Area.
04. Monument Signs in Sector C: This location typically has high-pedestrian traffic and less vehicular traffic. Roads within Sector C are OSU-owned and maintained. Monument signs will decrease in scale by 50% of Monument Signs outside of the OSU Boundary, and 25% less for Monument Signs within the OSU Boundary. This location is within the OSU Sign Exemption Area and construction and sign placement can proceed with no required sign permit.

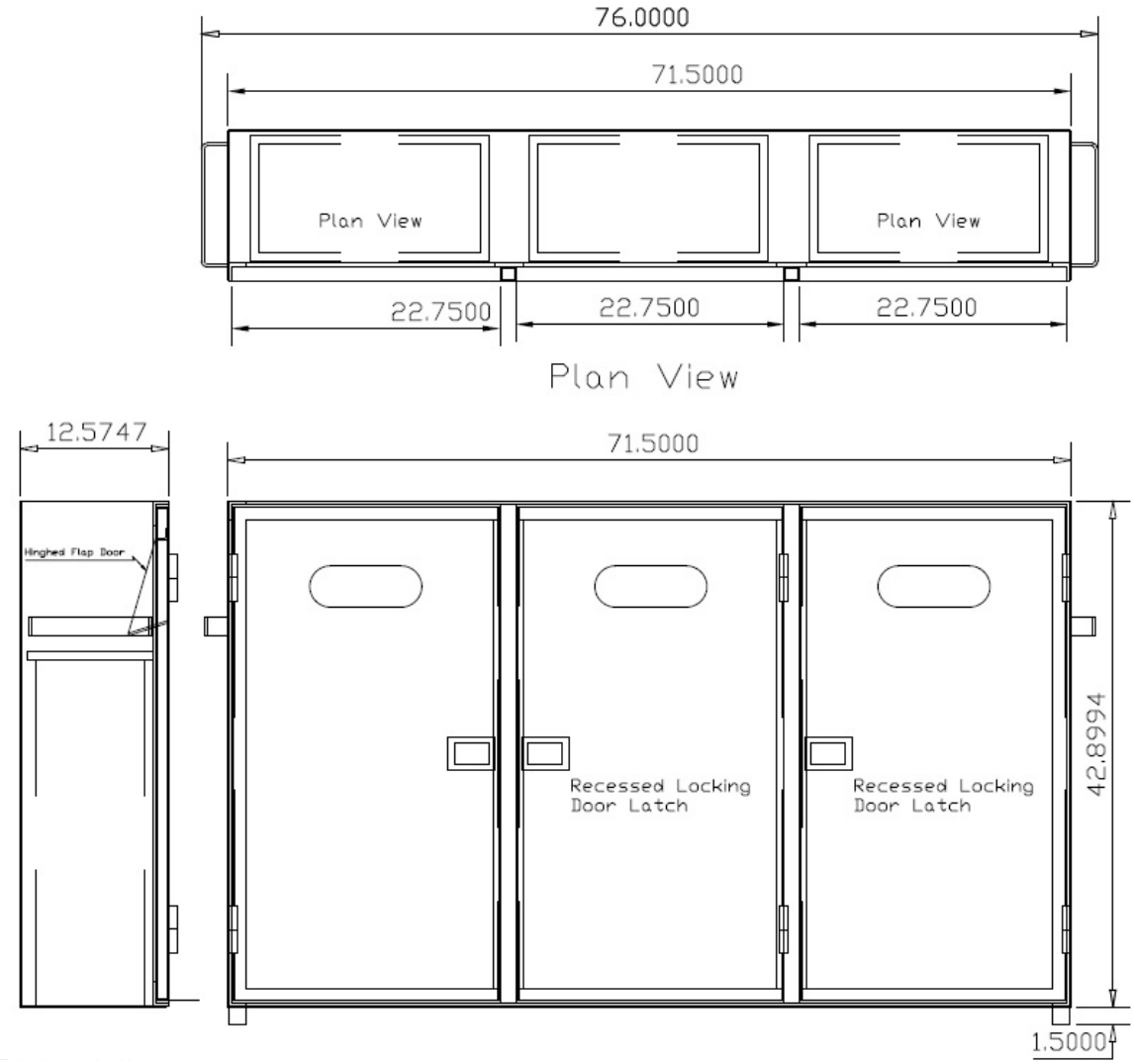
H. Recycling/trash Receptacles – Interior and Exterior

01. Metal receptacle: Combination recycling-trash receptacles should be placed where appropriate in landscape and site design. Outdoor receptacles are available in a 4- or 3-chamber design. Four-chamber receptacle should be used except in special cases where walkway width restrictions require a slimmer profile.

Receptacles are available from RJH Enterprises, Inc, Corvallis, Oregon. They hold 3 or 4 Rubbermaid 23 gallon “slim jims,” have full height internal partition and swinging doors that meet fire code for exterior AND interior use, and are constructed as per the drawings below. Receptacles must be powder coated.

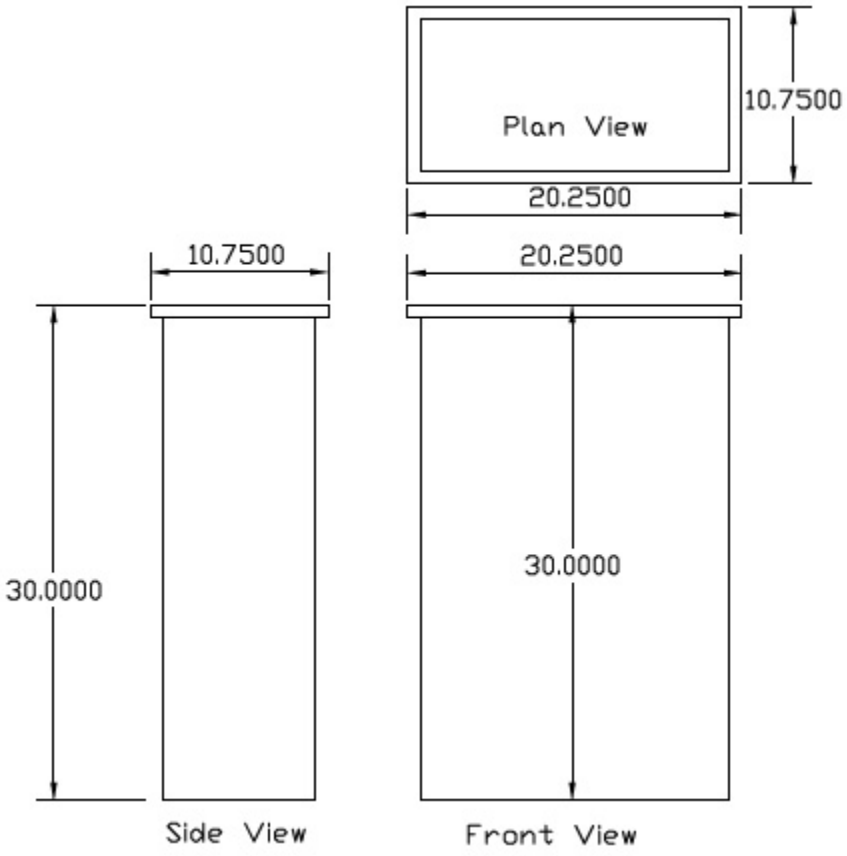


FOUR-Chamber Recycling-trash receptacle



THREE-Chamber Recycling-trash receptacle

02. Serviceable plastic insert: Rubbermaid 23 gallon “slim jims” with specifications and dimensions as per the following drawing.



Plastic insert for 3- or 4-chamber recycling-trash receptacles

I. Construction Sign Specification

01. EH&S has requested the following language be added to the sign:

If you have questions or concerns regarding this construction area, please contact the Facilities Services Work Coordination Center at 541-737-2969.

For after-hours safety concerns, please contact the Department of Public Safety at 541-737-3010.

Section 13 20 00 – SPECIALTY USE AREAS

PART 1 – GENERAL

1. REQUIREMENTS
   A. Specialty use areas can include laser rooms, high radioisotope use or biosafety level 3 or animal biosafety level 2 or 3. Due to their complex nature, design requirements for specialty use areas should be discussed with EH & S to determine specific needs. Design requirements will vary depending on user activity and the nature of work.

Section 13 25 00 – RESTROOMS

PART 1 – GENERAL

1. REQUIREMENTS
   - A. Floor drain.
   - B. Ceramic or Seamless floor.
   - C. Keyed hot water hose bib under sink.
   - D. Wall-mounted partitions, preferred.
   - E. Isolation valves.
   - F. Architect to show location, elevations, and correct size of bathroom accessories on plans.
   - G. In addition to the required restrooms per applicable building code requirements, a gender neutral, restroom shall be designed to meet the Universal Design Standards (Section 1.5, General Requirements). There will be a minimum of one single stall restroom per building. If only one restroom is designed, then it shall be located on the first floor of the building.
   - H. Other accommodations will include a changing table for infants.
   - I. All restrooms must meet at a minimum ADAAG 2010 guidelines and OSU best practices.

Section 13 29 00 – LABORATORY DESIGNATED EATING AND DRINKING AREAS

PART 1 – GENERAL

1. REQUIREMENTS
   - A. For all new laboratory buildings and major laboratory remodels, accommodations should be made to provide clean spaces that are designated as safe eating and drinking areas.
   - B. Designated eating and drinking areas should be physically separated from any location where laboratory chemical, biological or radioactive materials are used or stored.
     - 01. Physical separation can be accomplished by providing a door that prevents direct access between a designated eating/drinking area and a material use or storage location.
     - 02. The designated area must also be under positive pressure to the material use or storage location and be labeled as a clean space.
     - 03. A designated eating and drinking area could include but not be limited to a separate common lunch or break room per laboratory suite or floor OR personal office spaces that are separate from material use and storage locations.
     - 04. Eating areas should be large enough to accommodate the expected number of employees in each laboratory area that it will serve.

2. REGULATIONS AND STANDARDS
   - A. OAR Chapter 437, Division 2, Subdivision Z
   - B. OSU Campus Policy, Biosafety Manual

Section 13 30 00 – LOBBIES AND ATRIUMS

PART 1 – GENERAL

1. REQUIREMENTS
   A. Interior access into the atrium and within the atrium shall accommodate at a minimum a 32 inch wide high lift that extends 26 feet.
   B. The finish floor shall be constructed with materials to support the weight of a minimum a 32 inch wide high lift that extends 26 feet.

Section 13 31 00 – CUSTODIAL CLOSETS

PART 1 – GENERAL

1. REQUIREMENTS
   - A. Multi-story buildings must have at least one 150 sq. ft. room for supply storage (in addition to requirement B) with 48 linear feet of shelving.
   - B. Remaining floors require a minimum size -- 75 sq. ft. per floor with a minimum of 24 linear feet of shelving.
   - C. Floor type or wall mount type slop-sink with anti-siphon valve and clean out.
   - D. 20 amp electrical outlet.
   - E. A door that opens into a hallway.

Section 13 32 00 – INTERIOR STORAGE

PART 1 – GENERAL

1. REQUIREMENTS

A. OSU Buildings must have at least one 200 sq. ft room for general building storage.

B. 20 amp electrical outlet.

C. Environmentally controlled for general building use.

D. A door that opens into a hallway.

Section 14 20 00 -- Elevators

PART 1 - GENERAL

1. CONVEYING SYSTEMS
   - A. Hydraulic Elevators
     - 01. Work included: Installation of a new engineered HYDRAULIC elevator complete as described in this standard.
   - B. Submittals
     - 01. Submit bound operation and maintenance manuals for the new equipment (2 copies) with operating and maintenance instructions, parts listing, recommend parts inventory listing, purchase source, listing for critical component, emergency instructions, complete “as built” wiring and block diagrams including input signals, and diagnostic and/or trouble-shooting guide shall be furnished to Oregon State University.
       - a. Submit a complete list of all items to be furnished and installed under this section. Included manufacturer’s specifications, catalog cuts, and other data to demonstrate compliance with the specified requirements.
       - b. Submit complete shop drawings for all work in this section, showing dimensions and locations of all items including supporting structure and clearances required.
       - c. Manufacturer’s recommended installation procedures which, when approved by the Owner, shall be the basis for inspecting and accepting or rejecting actual installation procedures used on the work.
       - d. Submit (1) complete clean set of drawing prints and specifications with “as-built” conditions marked in crisp red ink. Sign and attest to the documents as reflecting all conditions “as built”.
       - e. Provide two (2) copies of Operation and Maintenance Manuals, Installation Manuals and Parts Manual necessary for full servicing of the elevator and microprocessor.
   - C. Quality Assurance
     - 01. Elevator installer is responsible for quality assurance and insuring that all systems related to the elevator are complete and functioning properly.
   - D. Use of Elevator
     - 01. The elevator shall not be used temporarily for building construction purposes unless specifically allowed by the Owner. General contractors shall be responsible for damage and repairs.
     - 02. If the contractor is allowed to use the elevator prior to substantial completion of the project, the warranty and service period shall not be compromised and shall begin when substantial completion is achieved after final inspection by the State of Oregon when Oregon State University takes possession.

2. ENGINEERED HYDRAULIC ELEVATOR
   A. Acceptable elevator manufacturers are:
      01. Motion Control Elevator Company
      02. Otis Elevator Company
      03. Thyssen Krupp
      04. All others with non-proprietary equipment
   B. Attributes
      01. Capacity: TBD
      02. Speed: TBD
      03. Operation: Selective Collective
      04. Control: Microprocessor based, Motion Control Engineering HMC-1000 oildraulic controller, TAC22 or other non-proprietary controllers.
      05. Travel: TBD
      06. Stops: TBD
      07. Openings: TBD
      08. Platform size: TBD
      09. Clear inside car: TBD
      10. Car doors: TBD
          a. Hoist way entrance: TBD
          b. Hoist way entrance finish: TBD
          c. Door operation: G.A.L. MOVFR System
          d. Signals: Illuminated car and hall operating buttons, illuminated by light emitting diodes. Tamper proof. Innovation Beaver Buttons.
          e. Provide emergency access in all hoist way entrances
          f. Photo curtain shall be model Janus Panachrome 3-D
          g. Car telephone shall be model no. Janus PSM phone
          h. Car enclosure
          i. Height not to exceed 50 feet of floor to floor travel
          j. Control panel (hinged to swivel for easy access) complete with the following:
             1. Car position and direction indicators, illuminated with light emitting diodes
             2. Fan key switch
             3. Emergency stop key switch
             4. Independent service key switch
             5. Fire-fighter service key switch
             6. Alarm bell push type switch
             7. Engraved capacity plate and elevator designation. Verify fabrication
             8. Light key switch
             9. Emergency light located in car control panel
             10. All keys shall be ex series 511-515
   C. Environmental Considerations

01. Ambient temperature: 50 F to 90 F
01. Humidity: not over 95% humidity
02. Vent machine room to outside to remove hydraulic fluid odors from building

D. Operation, Equipment and Function

01. Controller: Solid State control for hydraulic elevators. Dedicated permanent status indicators shall be provided on the controller to indicate the following: when the safety circuit is open, when the door locks are open, when the elevator is operating at high speed, when the elevator is on independent service, when the elevator is on fireman's service, when the elevator is out of service timer has elapsed or when the motor limit timer or valve timer has elapsed. In addition, provide means of displaying other special or error conditions that are detected by the microprocessor. The elevator shall not require the functioning or presence of the microprocessor to operate on car top inspection or hoistway access operation (if provided) in order to provide a reliable means to move the car if the microprocessor fails.
    a. The elevator controller shall utilize a microprocessor based logic system and shall comply with (ANSI/ASME 17.1) safety code for elevators. The control equipment shall have all control parameters stored permanently on erasable programmable read-only memories (EPROM), and shall have permanent indicators to indicate important elevator status as an internal part of the controller. The system shall provide comprehensive means to access the computer memory for elevator diagnostic purposes without need for any external devises. Systems that require hook-up of external devices for trouble-shooting must include device.
    b. Failure of any single magnetically operated switch, contractor, or relay to release in the intended manner or the occurrence of a single accidental ground or short circuit shall not permit the car to start or run if any hoistway door or gate interlock is unlocked or if any hoistway door or car door or gate contacts is not in the made position. Furthermore, while on car top inspection or hoistway access operation, failure of any single magnetically operated switch, contractor or relay to release in the intended manner or the occurrence of a single accidental ground shall not permit the car to move even with the hoistway door locks and car door contacts in the closed or made position.
    c. Dedicated permanent status indicators shall be provided on the controller to indiciate the following: when the safety circuit is open, when the door locks are open, when the elevator is operation at high speed, when the elevator is on independent service, when the elevator is on fireman's service, when the elevator is out of service timer has elapsed or when the motor limit timer or valve limit timer has elapsed. In addition, provide means of displaying other special or error conditions that are detected by the microprocessor.

d. A motor timer shall be provided which, in the event of the pump motor being energized longer than a predetermined time, shall cause the car to descend to the lowest landing, open the doors automatically and then re-close them. The car calls shall then be cancelled and the car taken out of service automatically. Operation may be restored by cycling the power disconnect switch or putting the car on access or inspection operation.
e. A valve limit timer shall be provided which shall automatically cut off the current to the valve solenoids if they have been energized longer than a predetermined time. The car shall then be cancelled and the car taken out of service automatically. Operation may be restored by cycling the power disconnect switch or putting the car on access or inspection operation.
f. An out of service timer (O.S.T.) shall be provided which will automatically take the car out of service if the car is delayed in leaving the landing while there are calls existing in the building. The car shall not respond to hall calls while in this mode of operation, and the photo eye in put shall be unresponsive in the event that a faulty photo eye unit was delaying the car.
g. Door protection timer shall be provided for both the open and close direction which will help protect the door motor and which will help prevent the car from getting stuck at a landing. The door open protection timer shall cease attempting to open the door after a predetermined time in the event that the door are prevented from reaching the open position. The door close protection timer will reopen the doors for a short time in the event that the door closing attempt fails to make up the door locks after a predetermined time.
h. A minimum of three different door standing open times shall be provided. A car call time value shall predominate when a car call only is cancelled. A hall call time value shall predominate whenever a hall call is cancelled. In the event of a door reopen from a photo curtain, or door open button, a separate short door time value shall predominate. The timing value for these timers must be field adjustable.
    1. Nudging: If the doors are prevented from closing for longer than a predetermined time, door nudging operation shall cause the doors to move at a slow speed in the close direction and to be unresponsive to the photo curtain. A buzzer shall sound while nudging operation is active.
i. Hall or car call registration and lamp acknowledgment shall be by means of a single wire per call besides the power busses. Systems that register the call with one wire and light the call acknowledgment lamp with a separate wire are not acceptable.

j. Fireman's Phase I emergency recall operation, alternate level Phase I emergency recall operation, and Phase II emergency in-car operation shall be provided according to applicable codes. Keyed EX 515.
k. Independent service operation shall be provided such that the actuation of a key switch in the car operating panel will cancel any existing car calls, and hold the doors open at the landing. The car will then respond only to car calls and will ignore hall calls. Car and hoistway doors will only close by constant pressure on car call buttons or a door close button until the car starts to move. While on independent service, hall arrival lanterns or jamb mounted arrival lanterns and gongs shall be inoperative. Keyed EX 513.
l. Simplex selective collective automatic operation shall be provided for all single car installations. Operation of one or more car or hall call buttons shall cause the car to start and run automatically provided the hoistway door interlocks and car door contacts are closed. The car shall stop at the first car or hall call set for the direction of travel. Stops shall be made in the order in which the car or hall calls set for the direction of travel are reached, irrespective of the order in which they were registered. If only hall calls are set for the opposite direction of travel exist ahead of the car, the car shall proceed to the most distant hall call, reverse direction, and start collecting the calls. For multiple car installations use duplex, triplex etc.
    1. The car shall be equipped with two-way leveling to automatically bring the car within plus or minus 1/8" of landing level at any landing regardless of load.
    2. A selector switch shall be provided on the controller to select high or low speed during access or inspection operation as long as speed does not exceed 150 feet per minute.
    3. A test switch shall be provided. In the "test" position, this switch shall allow independent operation of the elevator without the door open function for purposes of adjustment or testing the elevator. The elevator shall not respond to hall calls shall not interfere with the other car in a duplex installation.
    4. A timer shall be provide to limit the amount of time a car is held at a floor due to a defective hall call or car call including stuck push-buttons. Call demand at another floor shall cause the car to eventually ignore the defective call and continue to provide service in the building.
    5. Viscosity Control (optional and valve design must permit the use of this option) shall cause the car to accomplish the following operation. If a temperature sensor

determines the oil is too cold, and if there are no calls registered, the car shall proceed to the bottom landing and, as long as the doors are closed, the pump motor will run without the valve coils energized in order to circulate and heat the oil to the desired temperature. In the event the temperature sensor fails, a timer shall prevent continuous running of the pump motor.

E. Solid State Motor Starter

01. Provide a new solid-state motor starter to limit current inrush during starting and to provide gradual acceleration of the motor.
02. Motor starting shall not be initiated by mechanical contacts.
03. The starter shall include a current limit adjustment range of 200% to 450% of the overload adjustment range.
04. Provide an internal fault detention system, if the internal fault detection system detects a failure, power shall be removed from the motor.

F. Hydraulic Jack

01. All hydraulic elevators shall not be of the roped hydro type
02. All hole less jacks shall not be inverted
03. Install plunger-cylinder units plumb and accurate
04. Install schedule 40 PVC auxiliary casing with bottom completely sealed. Size casing for minimum 1.5” clearance to all jack assembly components
05. Install piping without routing underground. Where not possible, rout piping through schedule 40 PVC before back filing
06. Hydraulic hose for sound deadening is not permitted
07. All underground pipe is to be installed with PVC sleeve

G. Hydraulic Pump

01. Pumping Unit: The pumping unit shall be of integral design and shall include an electric motor connected to a submersible pump, a hydraulic control system, hydraulic fluid reservoir and necessary piping connections all compactly designed as a self-contained unit. This unit shall be designed for vibration free operation. The unit shall be factory adjusted and tested before shipment to the job site. The testing procedure shall include actual job type conditions of load, speed, etc. Refer to the drawings for remote arrangement of hydraulic unit for this project.
    a. The pump shall be specifically designed for all hydraulic operation and shall be of the positive displacement type. Oil flow shall be controlled in such a manner that car operation will be smooth and quiet in both directions of travel. Accurate car leveling shall take place in both the up and down direction. The control valve shall be easily adjusted from the front of the power unit.
    b. The “up start” system shall be adjustable and designed to initiate the stop of the elevator and shall control the declaration of the elevator smoothly and evenly.

c. The “down start” system shall be adjustable and designed to initiate the stop of the elevator and shall control the deceleration of the elevator smoothly and evenly.
d. The power unit shall have a shut off valve which will isolate the oil reservoir to enable servicing of the pump hydraulic assembly. The shut off valves shall be located in the machine room and in pit as directed by owner.
e. A suitable muffler designated to withstand the high pressures shall be installed in the power unit in a blowout proof housing.
f. Submersible Pump: The submersible pump shall be a positive displacement screw type to give smooth operation and shall be especially designed and manufactured for elevator service.

H. Elevator Pit Hydraulic Oil Return Pump
01. Drip Pan Return Pump: 120V fractional h.p. pump suitable for pumping of hydraulic fluid. Furnish pump with float activated on/off switch.
02. Drip Pan: 24 gauge, galvanized sheet metal of suitable size to accommodate return pump.
03. Provide self contained pump and reservoir to return oil to match RM tank.

I. Door Equipment
01. Heavy Duty G.A.L. MOVFR Door Operation System, G.A.L. door rollers, door hanger tracks (car and hall) door pick-up assemblies, gate switch, door locks.
02. Provide emergency access in all hoist way doors.
03. All doors shall have 1 – ½ hour label or other identification acceptable to governing authorities.
04. Provide adjustable nylon guide (by Nylube or Adams Elevator Equip. Co.)
05. Heavy duty doors. Provide door skin on both sides of elevator doors.

J. Lobby Position Indicator
01. Provide tamper resistant Innovation lobby position indicator on the ground level, illuminated by light emitting diodes.

K. Smoke Detectors
01. Smoke and heat detectors shall be compatible and tie into building fire system.

L. Hall Direction Indicator
01. Up and down tamper resistant as manufactured by Innovation. Direction indicators to be provided in the hall wall with a single chime or tone for up and double chime or tone for down direction and shall be illuminated by light emitting diode.

M. Photo Curtain
01. Photo Curtain: An electric, passenger sensing device of the photo curtain shall project across the entrance to prevent the car and hoist way doors from closing if a passenger or object interrupts the curtain.
02. Nudging: If the doors are prevented from closing for longer than a predetermined time, door nudging operation shall cause the doors to move at a

slow speed in the closed direction and to be unresponsive to the photo curtain. A buzzer shall sound while nudging operation is occurring.

N. Car Operating Station

01. Flush mounted operating panel shall be mounted in the car return panel and shall contain the devices required for the specified operation. The buttons and devices shall be of the easy readability type and the floor designation buttons shall become illuminated when pressed and shall stay illuminated until the floor call is answered. Provide continuous hinge on panel for easy access to internal components. Locate hinges on side of panel nearest wall of the elevator. The car operating shall contain the floor designations, and all the controls indicated.
    a. Beaver Buttons
    b. Car position indicator, illuminated with light emitting diodes
    c. Fan key switch
    d. Emergency stop key switch
    e. Independent service key switch
    f. Firefighter service key switch
    g. Alarm bell push type switch
    h. Light key switch
    i. Engraved capacity plate and elevator designation
    j. Emergency light

02. Elevator Shutdown
    a. Elevator power shall automatically shutdown prior to sprinkler activation. This is typically accomplished by the use of a shunt trip breaker activated by a heat detector.
    b. Heat detector to be located no more than 24” from any fire sprinkler head installed in elevator shaft or machine room
    c. Heat detector should also report to fire alarm system
    d. Conduit circuits to shut down elevator power shall be monitored and supervised by the Fire Alarm System

3. EXECUTION

A. Adjust and Balance

01. Make necessary adjustments of equipment to ensure elevator operates smoothly and accurately

B. Protection

01. Locate and protect movable equipment and controls in such a way that they can only be operated by authorized persons

C. Inspections

01. Obtain and pay for inspections and permits and make sure test is as required by regulations of authorities. Conduct all tests and inspections in the presence of the owners’ representative.

02. Final inspection shall be after all new equipment is installed and operating correctly.

03. Inspect installation in accordance with ANSI-A17.2
04. Deliver test certificates and permits to owner

D. Operation and Maintenance
01. Instruct Owner's personnel in proper use, operations and daily maintenance of elevators.
02. Training shall include operation of diagnostic microcomputer and servicing of elevator microprocessor.
03. Make final check of each elevator operation, with owner's personnel present and just prior to date of substantial completion. Determine that control systems and operating devices are functioning properly.

E. Cleaning
01. Remove all trash and debris from site during elevator installation
02. Clean and all elevator surfaces, removing all dirt, dust, spots, and scratches. Any damage shall be repaired or replaces as directed by owner, at not cost to owner.
03. Prior to substantial completion, remove protection from finished or ornamental surfaces and clean and polish surfaces with due regard to type of material.
04. Remove tools, equipment and surplus materials from site.
05. Paint car frame and hoistway equipment, pit floor and machine room floor.

4. NON-PROPRIETARY CONTROLS

A. Elevator control equipment must be non-proprietary, a site specific service tool which renders the control equipment non-proprietary must be provided with the elevator (ie. Map unit type, diagnostic service too.) The controller interface/service tool shall allow full access to fault codes and maintenance related parameters, and shall allow complete and thorough maintenance service to be performed by any properly licensed and qualified elevator Service Company. The controller and/or site specific service tool must come with a user's manual that effectively communicates to a qualified mechanic how to use the controller and/or tool, and also defined and explains all respective error codes, including required fixes. The service tool shall remain property of Oregon State University. Tool shall allow OSU to check on and change parameters of program.

5. ELECTRIC TRACTION ELEVATORS

A. Work included-Installation of a new engineered TRACTION elevator as described in this standard.

B. Submittals
01. Submit bound operation and maintenance manuals for the new equipment (2 copies) with operation and maintenance instructions, parts listing, recommend parts inventory listing, purchase source, listing for critical component, emergency instructions, complete "as built" wiring and block diagrams including

signals, pull sheets, and diagnostic and/or trouble-shooting guide shall be furnished to Oregon State University.

02. Submit a complete list of all items to be furnished and installed under this section. Included manufacturer's specifications, catalog cuts, and other data to demonstrate compliance with the specified requirements.
03. Submit complete shop drawings for all work in this section, showing dimensions and locations of all items including supporting structure and clearances required.
04. Submit two complete clean sets of drawing prints and specifications with "as-built" conditions marked in crisp red ink. Sign and attest to the documents as reflecting all conditions "as-built."
05. Provide 4 copies of Operation and Maintenance Manuals, Installation Manuals and Parts Manual necessary for full servicing of the elevator and microprocessor.

C. Quality Assurance
01. Elevator installer is responsible for quality assurance and insuring that all systems related to the function of the elevator are complete and functioning properly.

D. Maintenance
01. Starting at the time of substantial completion of the complete project, provide complete systematic inspection and maintenance of the elevator for a period of 12 months. Furnish trained experts and equipment to check, adjust, lubricate, and otherwise maintain the elevator in operation without defects or deterioration. Replace or repair materials and parts which become defective or deteriorated for any reason except through abuse or misuse by OSU. This time frame will start with final inspection of the elevator by the state of Oregon.

E. Use of Elevator
01. The elevator shall not be used temporarily for building construction purposes unless specifically allowed by the Owner. General contractor responsible for damages and repairs.
02. If the Contractor is allowed to use the elevator prior to Substantial Completion of the project, the warranty and service period shall not be compromised and shall begin when substantial completion is achieved. Final inspection by the state of Oregon is when OSU takes possession.

F. Acceptable elevator manufacturers are:
01. Kone Elevator Company
02. Motion Control
03. Otis Elevator Company
04. Thyssen Krupp
05. All companies with non-proprietary equipment

G. Attributes (Traction Elevator)
01. Traditional machine room set up at top of hoistway
02. Capacity: TBD

03. Speed: TBD
04. Operation: Selective collective
05. Control: Microprocessor based Motion Control Engineering VFMG-1000 for AC motor drive or TAC-50
06. Travel: TBD
07. Stops: TBD
08. Openings: TBD
09. Platform size: TBD
10. Clear inside car: TBD
11. Car Doors: TBD
12. Hoistway entrance: TBD
13. Hoistway entrance finish: TBD
14. Door Operations: G.A.L. MOVFR System
15. Signals: Illuminated car and hall operating buttons, illuminated by light emitting diodes. Tamper proof. Beaver buttons by Innovation Industries.
16. Provide emergency access in all hoistway entrances
17. Photo curtain shall be model Janus 3-D
18. Car telephone shall be model Janus PSM phone
19. Car enclosure:
    a. Control panel with the following:
        1. Janus
        2. Single button phone ADA compliant
        3. Car position and direction indicator, illuminated with light emitting diodes
        4. Fan key switch
        5. Emergency stop key switch
        6. Independent service key switch
        7. Fire-fighter service key switch
        8. Alarm bell push type switch
        9. Engraved capacity plate and elevator designation. Verify fabrication
        10. Light key switch
        11. Emergency light located in car control panel
        12. All keys to be Ex Series 511-515

H. Environmental Considerations
01. Ambient temperature: 50F to 90F
02. Humidity: not over 95% humidity
03. Vent machine room to outside

I. Operation, Equipment and Function
01. Controller: Dedicated permanent status indicators shall be provided on the controller to indicate the following: when the safety circuit is open, when the door locks are open, when the elevator is operating at high speed, when the elevator is on independent service, when the elevator is on fireman's service,

when the elevator is out of service timer has elapsed or when the motor limit timer or valve timer has elapsed. In addition, provide means of displaying other special or error conditions that are detected by the microprocessor. The elevator shall not require the functioning or presence of the microprocessor to operate on car top inspection or hoistway access operation (if provided) in order to provide a reliable means to move the car it the microprocessor fails.

02. The elevator controller shall utilize a microprocessor based logic system and shall comply with (ANSI/ASME 17.1) safety code for elevators. The control equipment shall have all control parameters stored permanently on erasable programmable read-only memories (EPROM), and shall have permanent indicators to indicate important elevator status's as an internal part of the controller. If external device is required for troubleshooting it must be supplied.
03. Dedicated permanent status indicators shall be provided on the controller to indicate the following: when the safety circuit is open, when the door locks are open, when the elevator is operationg at high speed, when the elevator is on independent service, when the elevator is on fireman's service, when the elevator is out of service timer has elapsed of when the motor limit timer or valve limit timer has elapsed. In addition, provide means of displaying other special or error conditions that are detected by the microprocessor.
04. An out of service timer (T.O.S.) shall be provided which will automatically take the car out of services if the car is delayed in leaving the landing while there are calls existing in the building. The car shall not respond to hall calls while in this mode of operation, and the photo eye input shall be unresponsive in the event that a faulty photo eye unit was delaying the car.
05. Door protection timer shall be provided for both the open and close directions which will help protect the door motor and which will help prevent the car from getting stuck at a landing. The door open protection timer shall cease attempting to open the door after a predetermined time in the event that the door are prevented from reaching the open position. The door close protection timer will reopen the doors for a short time in the event that the door closing attempt fails to make up the door locks after a predetermined time.
06. A minimum of three different door standing open times shall be provided. A car time value shall predominate when a car call only is cancelled. A hall call time value shall predominate whenever a hall call is cancelled. In the event of a door reopen from a photo curtain, or door open button, a separate short door time value shall predominate. The timing value for these times must be field adjustable.
07. Nudging: If the doors shall be prevented from closing for longer than a predetermined time, door nudging operation shall cause the doors to move at slow speed in the close direction and to be unresponsive to the photo curtain. A buzzer shall sounds while nudging operation is active.
08. Hall or car call registration and lamp acknowledgement shall be by means of a single wire per call besides the power busses. Systems that register the call with

one wire and light the call acknowledgement lamp with a separate wire are not acceptable.

09. Fireman's Phase I emergency recall operation, alternate level Phase 1 emergency recall operation, and Phase II emergency in-car operation shall be provided according to applicable local codes. Keyed (EX515)
10. Simplex selective collective automatic operation shall be provided for all single car installations. Operation of one or more car or hall call buttons shall cause the car to start and run automatically provided the hoistway door interlocks and car door contacts are closed. The car shall stop at the first car or hall call set for the direction of travel. Stops shall be made in the order in which the car or hall calls set for the direction of travel are reached, irrespective of the order in which they were registered. If only hall calls are set for the opposite direction of travel exist ahead of the car, the car shall proceed to the most distant hall call, reverse direction, and start collecting the calls. For multiple car installations use duplex, triplex, etc.
    a. The car shall be equipped with two-way leveling to automatically bring the car within plus or minus (1/4"0 of landing level at any landing regardless of load.
    b. A selector switch shall be provided on the controller to select high or low speed during access or inspection operation as long as speed does not exceed 150 feet per minute.
    c. A test switch shall be provided. In the "test" position, this switch shall allow independent operation of the elevator without the door open function for purposes of adjustment or testing the elevator. The elevator shall not respond to hall calls shall not interfere with the other car in a duplex installation.
    d. A timer shall be provided to limit the amount of time a car is held at a floor due to a defective hall call or car call including stuck push-buttons. Call demand at another floor shall cause the car to eventually ignore the defective call and continue to provide service in the building.

J. Door Equipment

01. Heavy Duty G.A.L. MOVFR Door Operating System to include, G.A.L. door rollers, door hanger tracks (car and hall) door pick-up assemblies, gate switch, door lock's.
02. Provide emergency access in all hoistway doors
03. All doors shall have 1-1/2 hr. label or another identification acceptable to governing authorities
04. Provide adjustable nylon guide
05. Heavy duty doors. Provide door skins on both sides of elevator doors

K. Lobby Position Indicator

01. Provide tamper resistant Innovation Co. lobby position indicator on the ground level, illuminated by light emitting diodes.

L. Hall Direction Indicator

01. Up and down tamper resistant direction indicators to be provided in the hall wall with a single chime or tone for up and double chime or tone for down direction and shall be illuminated by light emitting diode.

M. Photo Curtain

01. Janus 3-D Panachrome
02. Photo Curtain: An electric, passenger sensing device of the photo curtain shall project across the entrance to prevent the car and hoistway doors from closing if a passenger or object interrupts the curtain.
03. Nudging: If the doors are prevented from closing for longer than a predetermined time, door nudging operation shall cause the doors to move at a slow speed in the closed direction and to be unresponsive to the photo curtain. A buzzer shall sound while nudging operation is occurring.

N. Car Operation Station

01. Flush mounted operating panel shall be mounted in the car return panel and shall contain the devices required for the specified operation. The buttons and devices shall be of the easy readability type and the floor designation buttons shall become illuminated when pressed and shall stay illuminated until the floor call is answered. Provide continuous hinge on panel for easy access to internal components. Locate hinges on side of panel nearest wall of the elevator. The car opening shall contain the floor designations, and all the controls indicated.
    a. Beaver Buttons (Innovation)
    b. Car position indicator, illuminated with light emitting diodes
    c. Fan key switch
    d. Emergency stop key switch
    e. Independent service key switch
    f. Firefighting service key switch
    g. Alarm bell push type switch
    h. Light key switch
    i. Engraved capacity plate and elevator designation
    j. Emergency light

O. Elevator Shutdown

01. Elevator power shall automatically shutdown prior to sprinkler activation. This is typically accomplished by the use of a shunt trip breaker activated by a heat detector.
02. Heat detector to be located no more than 24” from any fire sprinkler head installed in elevator shaft or machine room
03. Heat detector should also report to fire alarm system
04. Conduit circuits to shut down elevator power shall be monitored and supervised by the fire alarm system

6. EXECUTION

A. Adjust and Balance

01. Make necessary adjustments of equipment to ensure elevator operates smoothly and accurately.

B. Protection
   01. Locate and protect movable equipment and controls in such a way that they can only be operated by authorized persons.
C. Inspections
   01. Obtain and pay for inspections and permits and make sure test are as required by regulations of authorities. Conduct all tests and inspection in the presence of the Owners representative.
   02. Final inspection shall be after all new equipment is installed and operating correctly.
   03. Inspect installation in accordance with ANSI-A17.2
   04. Deliver test certificates and permits to Owner
D. Operation and Maintenance
   01. Instruct Owner's personnel in proper use, operations and daily maintenance of elevators.
   02. Training shall include operation of diagnostic microcomputer and servicing of elevator microprocessor.
   03. Make final check of each elevator operation, with Owner's personnel present and just prior to date of substantial completion. Determine that control systems and operating devices are functioning properly.
   04. Continuing Maintenance: provide 1-year maintenance on elevators on as as-needed basis as part of standard 1-year warranty on new equipment and upgrades.
   05. Maintenance shall include systematic examination, adjustment and lubrication of new elevator equipment; replacement of seals, packing and valves to maintain required factor of safety; performance of maintenance work without removing car during peak traffic periods and providing 24 hour emergency call back service during maintenance period, at no additional cost to Owner.
   06. Repair or replace electrical and mechanical parts of the new elevator equipment using only genuine standard parts produced by manufacturer of equipment concerned.
   07. Ensure that competent personnel handle maintenance service. Maintain an adequate stock of parts for replacement of emergency purposes, locally, and have qualified personnel available at such places to ensure the fulfillment of this service without unreasonable loss of time.
E. Cleaning
   01. Remove all trash and debris from site during elevator installation.
   02. Clean all elevator surfaces, removing the dirt, dust, spots, and scratches. Any damage shall be repaired or replaced as directed by Owner, at no cost to owner.
   03. Prior to substantial completion, remove protection from finished or ornamental surfaces and clean and polish surfaces with due regard to type of material.
   04. Remove tools, equipment and surplus materials from site.
   05. Paint car frame and hoistway equipment, pit floor and machine room floor

Section 21050 – FIRE PROTECTION SYSTEMS

PART 1 – GENERAL

1. PROTECTION REQUIREMENTS

A. All spaces in the building must be fully protected by fire sprinklers. This requirement includes all spaces below suspended ceilings and above suspended ceilings where combustible materials are or are intended to be located. Plastic piping, telephone cabling, and plastic ductwork are examples of combustibles. All equipment must be UL listed and in the latest edition of the Factory Mutual (FM) Approval Guide.

B. In addition to the requirements of NFPA-13, the rulings and interpretations of the local Fire Marshal and the requirements of OSU must be incorporated into the design.

C. Dry Sprinkler Systems must be resettable externally by a plunger. For sensing Waterflow and Low Air, must use Potter PS10-2A for Waterflow and Potter PS40-2A for Low Air. If an accelerator is needed, must use Reliable Accelerator B1.

D. If at all possible, locate sprinkler riser in a mechanical room with direct outside access. Ensure that room is heated by a permanent fixed means or electrical heat source. Electrical heating tapes shall <u>not</u> be considered as an acceptable alternative means for freezer protection.

E. Indicate the location of all standpipe, tamper switches and flow switches. Provide a riser diagram showing major components.

F. All valve controlling water supplies for sprinkler systems of portions thereof, including floor control valves, shall be located for convenient access and operable from the floor level. When this provision is not feasible other approved means shall be provided. All sprinkler valves and controls shall be labeled.

G. Locate Backflow Preventers inside building.

H. <u>Do not</u> use riser mounted air compressors. Use the largest air compressor allowed by code.

I. The use of self-luminous exit signs containing radioactive material is prohibited unless specifically approved by Environmental Health & Safety (EH & S).

J. All Exit signs and Egress lighting must be on a dedicated Generator or UPS circuit or approved by the Alarm Shop.

2. REFERENCES

A. Uniform Fire Code – Latest edition.

B. NFPA13-Installation of sprinkler systems.

3. IDENTIFICATION

A. Provide labels and flow direction arrows on mains and cross mains every 20 feet.

Section 22 30 00 – PLUMBING EQUIPMENT

PART 1 – GENERAL

1. REQUIREMENTS
   A. Domestic Water System - System Requirements
      01. Reliability
         a. Adequate volume and pressure of water must be available at all times. On-site pressurization should be considered if the city supply is not reliable. Prior to the start of design work, contact the City of Corvallis Water Department to determine their requirements and pressures.
      02. Capacity
         a. System capacity shall be based on peak flow demand rates of the plumbing system, make-up to HVAC equipment, and process water requirements.
      03. Pressure
         a. A minimum domestic pressure of 35.0 psig is required at the most remote use points.
         b. If the public system cannot furnish this, provide booster pumps.
         c. Maximum water pressure within a building should not exceed 80.0 psi.
         d. Provide multiple pressure-regulating assemblies with a full line size bypass with isolation valves.
         e. Coordinate the location for easy maintenance.
      04. Design velocities
         a. To assure a quiet piping system, design velocities shall not exceed those noted below. Piping sized according to the velocities above still must not exceed the allowable pressure drops specified in the Uniform Plumbing Code, per the current Oregon amendments.
         b. Max. velocity
            1. Mains mechanical rooms: 10 ft. per sec.
            2. Mains and branches in other areas: 8 ft. per sec.
      05. Routing
         a. Route site fire and water lines to avoid other utilities, vaults, and trees.
         b. Coordinate routing with the landscaping plan to verify that no piping is within ten feet of any new tree and outside the drip line of any existing trees.

2. BUILDING SYSTEM
   A. Risers and mains

01. For ease of maintenance, locate risers and mains at or near an exterior wall in an accessible location, such as a mechanical equipment room, storage room, or custodial room.
    a. A main shut-off valve shall be installed on the riser before any branch take-off.
    b. Pipe runs below the building floor slab shall be avoided, except for short branch lines serving “island” fixtures.
02. In multi-story buildings, locate a shut-off valve on the branch feeding each level.
    a. In addition, provide sectional valves for each self-contained or special purpose area, to permit a localized shut-down without affecting other parts of the system.
    b. Provide shut-off valves for each toilet room.
    c. Provide an access door in the men’s toilet room with the shut-off valves for both toilet rooms.

B. Backflow prevention
01. All industrial water, such as lines labs, HVAC equipment, cooling water, or other water make-up systems to equipment shall have a pressure-reducing type backflow preventer (RPBP) located in an accessible location.
    a. A floor sink or other approved fixture shall be nearby to receive piped discharge from the RPBP.
    b. Back-flow protected lab water shall be identified differently from that serving domestic purposes, such as drinking fountains, kitchens, and rest rooms, etc.
02. Kitchen equipment with chemical injection systems (ie. dishwashers, hood wash systems, beverage systems) require a pressure-reducing type backflow preventer (RPBP) located in an accessible location. A floor sink or other approved fixture shall be nearby to receive piped discharge from the RPBP.
03. All potable building supply water shall be protected by two (2) backflow preventers (BFP), installed in parallel to allow for testing or repair of the device without shutting off the building’s water supply. Provide unions or flanges on both sides of the device.
04. Provide a bypass around each backflow prevention device to allow for service and maintenance.

C. Water hammer protection
01. A sealed chamber-type, maintenance free, water hammer arrestor shall be installed upstream of all solenoid valves, flush valves, water mixing valves or other quick-closing valves.
    a. The size, quantity, and location are to be as recommended by the manufacturer of water hammer arrestors.
    b. Simple air-chamber type units are not acceptable.

D. Trap primers
   01. Trap primers shall be provided to protect the trap seal of infrequently used fixtures (generally floor drains).
      a. A single trap primer may be used to serve more than one fixture. A manifold provided by the trap primer manufacturer shall be provided. Provide access for inspection or locate trap primers exposed.
      b. Provide a shut-off valve on the water supply line to the primer.
      c. Locate trap primers in an easily accessible location.

E. Water heating
   01. Provide steam to hot water generators for domestic hot water.
   02. Specifications:
      a. The hot water temperature at any fixture shall not exceed 110 deg. F, as per plumbing code. Generate water at temperatures necessary to attain 110 deg. F at taps. Provide a recirculating system controlled by an aquastat. Special use areas such as kitchens and certain labs may require higher temperatures.
   03. Selection of water heater capacity shall be based on the recommendations of the ASHRAE Handbook for Hot Water Systems or on other standard engineering practices.
   04. Use the Uniform Plumbing Code for sizing pipe.
   05. Some areas or equipment may require higher temperatures than the 140 deg. F, recommended above, such as cafeterias, kitchens, etc. In such cases, a separate heater or local booster heaters of appropriate capacity shall be used.
   06. Use of electric instantaneous units may be used at remote isolated locations. Preferred manufacturers.
      a. Controlled Energy Corporation, Powerstar, Powerstream, or Ariston with a minimum five year warranty.

F. Fixtures
   01. Fixtures shall be selected for the specific function. Where possible, water saving features should be employed, particularly in high use areas.
   02. Fixtures shall be a water conservation type, as required by code.
   03. Provide fixtures in accordance with Americans with Disabilities Act Guidelines (ADAAG). Where applicable building code requirements are more stringent, those code requirements shall be followed.
   04. Material shall be the best quality, easy to clean, with surfaces smooth and resistant to chipping, cracking, and discoloration.
   05. Water closet, lavatory, and urinal shall be of white, vitreous china.
   06. Sinks (coffee bar, break area) shall be 18 gauge, type 304 stainless steel, unless specifically requested otherwise.
   07. The custodial sink shall be cast stone or stainless steel.

08. Faucets, hose bibs, and flush valves in valves in toilet areas shall be chrome-plated brass.
09. Floor drains and floor sinks are generally cast iron with a polished bronze heel proof grating.
10. Provide sink and shelving adjacent to the cooling tower chemical treatment area.
11. Drinking fountains will be the "high-low" dual use type, one at standard height and one at ADA height. A minimum of one drinking fountain per floor should be lower "wheelchair" height and locate on the accessible route of travel. Provide refrigerated fountains only where cold domestic water temperature at the point of service is 75 deg. F or higher. Refrigerated fountains should be installed on a timer or tied to building management systems to prevent running during unoccupied hours.

G. Piping materials
   01. Use Type L copper for all domestic cold and hot water, and recirculated hot water piping and all water piping down stream of RP devices

H. Valves
   01. Select valves for the appropriate function:
      a. Gate valves or butterfly valves or ball for shut-off or sectionalizing service, globe valves for flow modulation.
      b. Specialty valves shall be employed where appropriate, such as check valves on a pump discharge, pressure regulating valves for equipment requiring lower-than-available system pressure, solenoid valves, etc.
      c. Flanged or threaded end valves are preferred.
      d. Locate valves in accessible locations, not more than six feet above the floor, if frequently used, and with a union on the downstream side of threaded end valves.
   02. The specifications shall require that the Contractor is to furnish to the OSU Project Manager four copies (one framed) of an “as-built conditions” diagram for each mechanical equipment room, showing a piping diagram and the location of the main shut-off valves for gas, fuel oil, hot and cold water, the fire sprinkler main, etc.
      a. The diagram shall be simple, easy to follow, and with valves highlighted or shown prominently.
      b. Provide each valve with a brass disc not less than 1-1/4” diameter engraved with numbers, piping service, and normal operating position (i.d. NO, NC) corresponding to valves shown on diagrams.
      c. Fasten discs to valves with #14 brass wire or #16 brass jack chain.
   03. Consult with the OSU Project Manager to determine location and quantity of isolation and sectionalizing valves for all liquid systems.
   04. Galvanized piping shall not be used in any water system.

I. Insulation
   01. Insulation is required for all hot water piping, cold water and industrial cold water piping.
   02. Insulate horizontal portions of rain water piping above ceilings or finished soffits in areas where there is a possibility of condensation.
   03. Provide flexible molded vinyl insulation kit on exposed waste and supply piping below ADAAG lavatories and sinks.

J. Accessories
   01. Pipe line accessories such as unions, pressure or temperature test plugs, flow sensors, gauges, flexible connectors, etc. shall be employed as appropriate to assure a well-functioning, easy-to-maintain system.
   02. Expansion joints or expansion loops shall be installed on long, straight runs to compensate for thermal expansion of the pipe whenever the calculated expansion is +/- 1/8 inch or more. Spacing and location shall be based on the maximum probable temperature fluctuation and the thermal coefficient of the pipe material.

K. Supports
   01. For parallel pipe runs, trapeze-type supports shall be spaced to suit the smallest pipe in the group. Spare room for 20% future pipe lines should be reserved.
   02. Hanger spacing shall also be coordinated with the supporting steel overhead. Hangers shall be of sufficient strength to support the pipes and contents plus 200 pounds. Metallic pipes shall not be in direct contact with hangers or the supporting structure.
   03. Provide seismic bracing according to SMACNA requirements.

3. SANITARY SEWER SYSTEMS

A. Design criteria
   01. Capacity
      a. All calculations for pipe capacity shall be based on the current Plumbing Code. Cooling tower blowdown will also discharge into the sanitary sewer system.
   02. Slope (pitch)
      a. Slopes of sanitary sewer lines within a building are set by code. Verify that design considerations are acceptable to local jurisdictions and obtain approval prior to proceeding with design work.
   03. Tests
      a. Sanitary sewer systems are tested per code, generally tested at 10 feet of head for a period of 4.0 hours with no visible loss of water.
      b. The exceptions are pumped portions, which should be tested at 1 1/2 times the pump head.

B. Routing
   01. Route site sanitary lines to avoid other utilities, vaults, and trees.
   02. Coordinate routing with the landscaping plan to verify that no piping is within ten feet of any new tree and outside the drip line of any existing trees.

C. Material
   01. Hubless cast iron or galvanized steel pipe is acceptable.
      a. Below-grade portions of piping shall be hubless plain-end cast iron piping to a point five feet beyond the exterior face of the building.
      b. Specify 4 band fittings above and below grade.

D. Freeze protection
   01. The minimum depth of pipe cover must be three feet, or one foot below the frost line, whichever is greater.

E. Building sewer system
   01. Vents
      a. Provide vents in accordance with code. To reduce the number of roof penetrations, collect vents in the ceiling or attic space.
   02. Cleanouts
      a. In addition to code requirements, provide cleanouts at major pipe junctions. Avoid locations such as lobbies, conference rooms, private offices, or other special areas.
   03. Floor drain system
      a. Provide traps and vent at all floor drains directly connected to the sanitary sewer. Pipe runs should be located between columns to avoid footing pressure zones.
   04. Distribution of floor drains shall be:
      a. In mechanical equipment rooms at appropriate points to collect discharge or drainage from equipment.
      b. Near water heating equipment.
      c. In each toilet room.
      d. At each emergency shower.
   05. Drains serving outdoor wash pad areas, trash enclosures, loading docks or other areas that could conceivably generate contaminated rain-water runoff and/or contaminated process water, shall be plumbed to the sanitary sewer system. Plumbing code requirements may dictate the use of a fixed roof, diking or slope control to minimize rain water collection.

4. STORM DRAINAGE SYSTEM
   A. Design criteria
      01. Rainfall intensity
         a. The system design shall be based on the 50-year storm rainfall intensity for the City of Corvallis or local code requirements, whichever is higher.

02. Slope
    a. Provide an engineering analysis to determine a pipe size, considering flow, velocity, and available fall. Design for pipe with space capacity.
03. Tests
    a. Same as the sanitary sewer system.
04. Routing
    a. Route site storm lines so as to avoid other utilities, vaults, and trees.
    b. Coordinate routing with landscaping plan to verify that no piping is within ten feet of any new tree and outside the drip line of any existing trees.

B. Building drainage system
01. Roof drains, overflows, gutters
    a. Cast iron or bronze roof drains shall be distributed to serve approximately equal areas.
    b. An overflow drain shall be located within five feet of each roof drain with the rim 2" above finished roof surface.
    c. Overflow drains shall be connected to an independent drainage system, discharging at a point visible from the outside.
    d. Discharge locations shall be selected so as not to spill or splash over or down the exterior walls of the building so as to avoid unsightly staining.
    e. Pipe sizing for the overflow pipe system is to be the same as for the roof drains.
02. Roof Drains: Provide minimum 4" diameter drainpipe wherever feasible to minimize obstructions. Provide cleanouts (and access panels for drainlines routed through walls, interior spaces, and outside the building. Provide removable scupper covers with sufficient flow to minimize leaf obstructions.
03. Rainwater leaders
    a. Materials for the roof drainage and overflow piping is to be identical.
    b. Hubless cast iron or galvanized steel pipe is acceptable. Vertical drops shall be located adjacent to exterior walls.
    c. Below-grade portions of piping shall be hubless plain-end cast iron piping to a point five feet beyond the exterior face of the building.
    d. Specify 4 band fittings above and below grade.
    e. One vertical leader may serve only one roof drain.
    f. Extend rainwater leaders below the grade and connect it to an on-site storm drainage system or run it to the site civil piping system.

04. Sump pumps
    a. For small, independently drained areas (area ways, ramps, loading docks), a small local sump and pump will be required if no gravity connection to the mains is possible.
    b. The simplest arrangement shall be employed, utilizing a small, cast-in-place sump with submersible pump(s). Sloping surfaces shall direct rainwater to the sump.
    c. In areas where a build-up of rainwater is not critical, a single pump is acceptable. In other situations or as designated by local jurisdiction, duplex pumps shall be used.
    d. Pumps shall be controlled by integral or separate level sensors.
        1. Duplex pumps are to have an automatic alternating arrangement.
        2. An additional level sensor shall be provided at all sumps to signal high liquid level alarm conditions.
    e. An oil/water separator shall be provided prior to the sump pumps where required, as designated by the local jurisdiction.

5. NATURAL GAS SYSTEMS (FUEL GAS)
   A. Design criteria
      01. General
          a. Natural gas shall be considered the primary fuel for kitchen cooking equipment.
      02. Pressure
          a. The gas pressure is normally located by the seven-inch water column on the downstream side of the gas meter.
      03. Capacity
          a. The capacity of the system is the total connected load from all present and future use points.
      04. Piping
          a. The pipe above grade shall be:
              1. threaded or welded black steel where located inside a building
              2. galvanized steel where exposed to the weather.
          b. The pipe above grade, when exposed, shall be painted with paint suitable for corrosion protection.
   B. Valves
      01. Valves shall be readily accessible and located as designated by code and local utility company requirements.
      02. Provide valves at each capped stub out for future extension, and at each piece of equipment. Request the local utility company to provide a valve upstream of the gas meter.
   C. Accessories

01. Provide a gas pressure regulator with a built-in internal relief and low-pressure cut-off, or for large demands, a gas pressure regulator with an internal relief and separate low-pressure cut-off.
02. Vents shall be provided from each pressure regulator. Vents shall run independent and terminate outside the building at a location in compliance with code.
03. Provide pressure gauges with gauge cocks on the upstream and downstream side of each regulator and a separate low pressure cut-off to aid in checking the gas pressure.

D. Tests
01. Gas piping shall be tested with air at 100 psig for four hours with no loss in pressure.

E. Gas supply
01. Coordinate the location of the gas meter with Northwest Natural Gas Company.
02. Northwest Natural Gas Company has all known gas pipe lines documented.

6. BUILDING SYSTEM

A. Pressure
01. Piping within the building shall be sized and distributed at 6.5-7" water column, unless a higher pressure is required for the equipment.

B. Piping
01. All piping shall run above the slab, with branches connected to the top of mains. When necessary, due to structural conditions, piping may be installed in other locations with the permission of the local jurisdiction. Use welded fittings for pipe larger than two inches or for pressures 1.0 psig or greater.

C. Equipment connections
01. All connections to equipment shall terminate with a dirt tee and shut-off valve. Flexible connectors are not acceptable.

7. MANUFACTURERS

A. OSU maintains a stock of spare plumbing parts for most components on campus.
B. The table below lists preferred brand and manufactures for plumbing components.
C. The brand of company name listed is to be used as the basis of design for that component. Provide a list of alternate manufacturers to the OSU Project Manager for review with the OSU shops with the 100% design development documents. Provide a list of any changes or additions with the 95% construction document review.

Domestic Water/ Non-potable Water		Gas	Waste	Vent	Item	Brand or Company
Hot	Cold					
X	X				Back-flow prevention devices	Febco
X	X				Control Valves	Honeywell or Johnson
X	X				Cross connection devices (preferred)	Febco
	X				Drinking fountains & water coolers	Haws Elkay
X	X				Faucets	Chicago, Zurn, Moen
	X				Faucets	Delta, Moen
X					Hose bibs, freeze-proof	Josam & J.R. Smith
		X			Lab fixtures	J&S, Chicago, Water Saver
X	X				Lab fixtures	J&S, Durcon, Water Saver
		X			Pipe & Fitting, black steel	
			X	X	Pipe & fittings, cast iron, no Hub	
				X	Pipe & fittings, PVC schedule 40	
X	X				Pipe, type L Copper	
			X		Prime-Eze Water Saver Trap Primer	Jay R. Smith MFG. Co.
X	X				Valves	Stockham, Grinnel
X	X				Valves, ball	Apollo
X	X				Valves, ball - PVC	Omni-Spears
X	X	X			Valves, brass ball	Gem
X	X				Valves, flush	Sloan, Royal, Zurn; Moen
X	X				Valves, gate	Nibco
X					Valves, pressure	Watts
X					Valves, pressure regulating	PRV Spence
X	X				Valves, rising stem valve - NONE above 2"	Stockham, Grinnel
	X				Water closet - flush valve	Kohler: Kingston, Highcrest, Highcliff, or Stratton Water-Gard
	X				Water closet – tank type	Kohler: Highline Pressure Lite, or Wellworth Pressure Lite
	X				Urinal	Kohler: Bardon, Stanwell, or Dexter
X					Steam to hot water heat exchanger	Aerco, Armstrong,

Domestic Water/ Non-potable Water		Gas	Waste	Vent	Item	Brand or Company
Hot	Cold					
						Patterson-Kelley
	X				Emergency shower and eye wash	Haws, Water Saver (Guardian)

Section 22 45 00 – EMERGENCY PLUMBING FIXTURES

PART 1 – GENERAL

1. REQUIREMENTS
   A. These criteria set OSU campus standards for emergency shower and eyewash equipment to comply with the regulations set forth in the most current applicable OAR.

2. EMERGENCY EYE WASH
   A. This equipment must meet the performance and installation requirements the most current American National Standards Institute (ANSI).
   B. All campus laboratories that use substances described above must have at least one emergency eye or eye/face wash located within the laboratory and as close as possible to the hazard.
      01. Hand held drench hoses are not considered eyewash units. They may be used in addition to equipment, which is described as meeting the ANSI standard. In some cases, a sink mounted eyewash and a drench hose may be installed in lieu of a combination eyewash/safety shower.
      02. Consult OSU EH&S for review and approval of this configuration.
   C. Approved emergency eye or eye/face wash units are Haws 7611 or Guardian G1805 (laboratory unit – install at sink), Haws 7000BT or Guardian G1750PT (Barrier Free), Haws 7656WC or Guardian GBF 1735DP (recessed), or equal. The approved units must be:
      01. Supplied by domestic water.
      02. Readily visible and accessible to the laboratory or work site. The unit should be located as close to the hazard as possible and cannot be blocked by building structures, cabinets, supplies or equipment.
      03. Regulated to provide a spray force of three to six gallons per minute at 30 psi.
      04. Mounted such that the water nozzles are 33 inches to 45 inches from the floor level; height should comply with the current Americans with Disabilities Act (ADA) requirements.
      05. Mounted so that spray nozzles, when activated, are no more than 18 inches from the counter front when located above work counters or benches.
      06. Provided with an activation device, such as stay open ball valve, that allows the user full movement of both hands after the valve is turned on.
      07. Identified with a highly visible sign.
      08. Drain will be plumbed to sanitary sewer.
      09. No electrical outlets within 6 feet unless GFI protected.
      10. Indoor units are not required to deliver tempered water. Units installed outdoors or in adverse climates may need to be tempered. The need for

tempered water shall be reviewed and approved by OSU EH&S during the design phase.

3. EMERGENCY SHOWERS

A. Emergency Showers must be a combination unit that meets the requirements of current ANSI standards. The unit must be installed and located so both the shower and eyewash can be used at the same time by one person. Approved eyewash/emergency shower units are Haws 8346 or Guardian G1909 HFC (GBF1909 Barrier Free), Haws 8355WC (recessed), Guardian GBF2150 (recessed), or equal. The approved units must be:

01. Supplied by domestic water.
02. Readily visible and accessible to all occupants of the laboratory or work site. They cannot be blocked by building structures, cabinets, supplies or equipment.
03. Adequately supplied with potable water to meet the requirements of each component. The shower must be able to deliver a minimum of 30 gallons per minute. The diameter of the water pattern of the shower measured 60 inches above the surface on which the user stands must be a minimum of 20 inches. The center of the spray pattern shall be located at least 16 inches from any obstruction.
04. Supplied by a minimum iron pipe size of 1 inch.
05. Installed with a stay open ball valve.
06. Installed so that the shower head is not less than 82 inches nor more than 96 inches from the surface on which the user stands.
07. Identified with a highly visible sign.
08. Eyewash component drain must be plumbed to sanitary sewer.
09. Located so as not to pose an electrical shock hazard. No electrical outlets within 6 feet unless GFI protected.
10. Indoor units are not required to deliver tempered water. Units installed outdoors or in adverse climates may need to be tempered. The need for tempered water shall be reviewed and approved by OSU EH&S during the design phase.
11. A dedicated water shutoff valve shall be located within 10-feet of the shower unit.

4. LOCATION OF EMERGENCY EYE WASH AND/ OR SHOWER

B. A combination eyewash/emergency shower may be located outside the laboratory area provided an approved eyewash is located in the laboratory.

C. The combination unit must be located so that travel distance is no more than 10 seconds with no obstructions and only one door to pass through to reach the unit. Note: Emergency eyewash or eye/face wash shall be plumbed to sanitary sewer or sink-mounted.

D. OSU EH&S will make final determination on selection of “equal” equipment to ensure the equipment meets current ANSI standards.

Section 22 60 00 – SPECIAL SYSTEMS

PART 1 – GENERAL

1. COMPRESSED AIR
   - A. General Requirements
     - 01. Verify with the OSU Project Manager the type and quality of compressed air required.
     - 02. OSU uses two types of compressed air systems: clean lab air and building air. Verify the type of air required with the OSU Project Manager.
   - B. Lab Air System
     - 01. The compressed air system shall include the following:
       - a. Air or water cooled one or two stage rotary screw type oil-free air compressor.
       - b. An air dryer.
       - c. An air receiver (located between the compressor and dryer).
       - d. A filtered intake to the compressor.
       - e. Particulate filters.
       - f. Activated Carbon Filters.
       - g. Copper piping system cleaned for oxygen service.
       - h. Preferred manufacturer: Quincy Northwest.
     - 02. Once through cooling water is not acceptable on water cooled units. Provide an integral heat exchanger and a cooling fan.
     - 03. "Oil-free" compressors, which depend on various seals to keep oil out of the air, or those equipped with oil filters located after the compression chambers, may be acceptable. Consult with the OSU Project Manager. Provide a receiver with a by-pass upstream of the dryer.
     - 04. Air dryers are to be either refrigerated type or the desiccant heatless, reactivated dual tower type. Verify with the OSU Project Manager the desired dew point (-40 deg F. -100 deg. F.) and select the appropriate dryer. Locate dryers as close as possible to the point of use.
     - 05. Size the air intake filter for 150% of the compressor flow rate.
     - 06. Provide final particulate filters upstream and downstream of the dryer with a rating of 0.1 micron absolute for particle removal.
     - 07. Install a "coalescing" filter upstream of the receiver tank and particulate filter downstream of the dryer. Use Type 304 stainless steel housings. Install these devices in parallel with the gauges and isolation valves.
   - C. Building Air System
     - 01. The compressed air system shall include the following:
       - a. Air or water cooled one or two stage rotary screw type oil flooded air compressor
       - b. A air dryer
       - c. A air receiver (located between compressor and dryer)

d. A filtered intake to the compressor
e. Particulate filters
f. Coalescing filters
g. Copper piping system
h. Preferred manufacturer: Quincy Northwest.

02. Once through cooling water is not acceptable on water cooled units. Provide integral heat exchanger and cooling fan.

03. Air dryers are to be either refrigerated type or the desiccant heatless, reactivated dual tower type. Verify with the OSU Project Manager the desired dew point (-40 deg F, -100 deg F) and select the appropriate dryer. Locate dryers as close as possible to the point of use.

04. Size the air intake filter for 150% of the compressor flow rate.

05. Install "coalescing" filter upstream of the receiver tank and particulate filter downstream of the dryer. Use Type 304 stainless steel housings. Install these in parallel with the gauges and isolation valves.

D. Piping

01. Lab Air System

a. ASTM 280 ACR Type L copper above grade, Type K below grade; wrought copper fittings, 15% silphos silver solder for OFA and Nitrogen. Piping must be installed while maintaining a continuous inert gas (argon or nitrogen) purge during the entire installation period.

b. Identify all compressed air piping per general requirements.

c. Cleaning of piping.

1. The most important single requirement for the process gas piping systems is that they are suitable and capable of conveying a gas from the source to use point with no contamination.

2. Order all pipe material, fittings, etc., to be cleaned by the manufacturer for "oxygen usage", charged with nitrogen, and sealed at the ends prior to transportation.

3. Each pipe length and fitting is to be individually inspected on arrival at the job site for integrity of the sealed ends and for physical injury (such as bends or flat spots). Pipes with lost seals or physical damage are to be re-cleaned or rejected.

4. Acceptable pipes are to be stored in a clean, safe location.

5. Quantities of pipe cleaned at any one time shall not exceed that which can be installed within the same working days. No pipe may be installed if the plastic

bags on the ends of the pipe are not “puffed up”, which indicates a loss of the N2 charge.

6. Pipes, valves and/or fittings which do not comply with the cleaning standards (i.e. which show contamination at specified stages of the cleaning process) must be rejected and removed from the site.

02. Building Air System

a. Type L copper above grade, Type K below grade; meeting ANSI 11.1, wrought copper fittings, brazed.

b. Identify all compressed air piping per general requirements.

E. Valves

01. Lab Air System

a. All valves for the oil free air systems shall meet these specifications:

b. Non-lubricated.

c. Cleaned for “oxygen usage” at the factory.

d. Packaged and sealed individually in heavy duty polyethylene bags with a nitrogen charge.

e. Pressure rated for a minimum of 1.5 times working pressure.

f. Inspected prior to installation.

g. Have an extension at each end (except flanged valves).

02. Building Air System

a. Ball valves shall have a (3) piece design to permit servicing without cutting the pipeline.

b. Check valves shall be spring loaded.

c. Provide ball type shutoff valve and female connection on outlet of valve for connection by user. Verify with the OSU Project Manager exact requirements.

d. Provide isolation valves at each floor, at each lab, and at each point of use.

2. LAB VACUUM SYSTEM

A. General Requirements

01. Use belt drive air cooled or water cooled duplex rotary vane or hook and claw type units. Once through cooling water is not acceptable.

02. Provided make-up water to the closed system from an isolated industrial cold water source.

03. Cooling system provided as part of the unit complete with all necessary pumps, heat exchanger and controls to maintaining cooling water flow rate.

04. Maintenance drain valves and drain tubing is to be included in the pump housing and heat exchanger.

05. System to include factory controls for unit staging.

06. Preferred manufacturer: Quincy.
07. Lab vacuum discharges shall be a minimum of 16 feet above the roof line.

B. Piping
01. Type L copper above grade; Type K below grade; wrought copper fittings, soldered.
02. Identify all compressed air piping per general requirements.
03. Use of schedule 80 PVC with solvent welded joints may be allowed in certain cases. Contact the Project Manager for approval.
04. Identify all vacuum air piping per general requirements.

C. Valves
01. Ball valves shall have a (3) piece design to permit servicing without cutting the pipeline.
02. Provide a ball type shutoff valve and a threaded female connection on outlet of valve for connection by user. Verify with the OSU Project Manager exact requirements.
03. Provide isolation valves at each floor, at each lab, and at each point of use.

3. GAS SYSTEMS

A. General
01. The quality of the specialty gas systems to be delivered should be suitable for the intended use.
02. The OSU Project Manager will provide a list of gasses required on the project and the piping materials to be used.
03. If extending an existing system the materials and cleanliness specifications shall match existing system. Only at the directive of the OSU Project Manager should variations from existing systems be made.
04. Medical gas system piping shall be designed and installed per NFPA 99.

B. Piping
01. Where gas systems will be carried in copper piping use the above requirements for lab air systems.
02. Where gas systems will be carried in stainless steel piping:
a. Special cleaning requirements must be followed (see below for detailed description).
b. Acceptable materials for gas systems, unless requested otherwise are:
1. Type 316 stainless steel tubing
2. Valves
3. All valves for the cleaned dry air and Nitrogen systems shall be:
3.B.02.b.3.1 Non-lubricated
3.B.02.b.3.2 Pressure rated for a minimum of 1.5 times working pressure

3.B.02.b.3.3 Inspected prior to installation
3.B.02.b.3.4 Have an extension at each end (except flanged valves)

c. Valves
1. Ball valves shall have a swing-out center to permit servicing without cutting the pipe line.

03. Identify all vacuum air piping per general requirements.
04. Provide isolation valves at each floor, at each lab, and at each point of use.

C. Accessories and supports
01. The body material of pipe line accessories and specialty valves, such as pressure regulating valves, flow monitoring devices, etc., must match the material of the piping system, and internal parts shall be compatible with the particular gas.

D. Cleaning of piping
01. The most important single requirement for the gas piping systems is that they are suitable and capable of conveying a gas from the source to use point with no contamination.
a. Order all pipe material, fittings, etc., to be cleaned by the manufacturer, charged with nitrogen, and sealed at the ends prior to transportation.
b. Each pipe length and fitting is to be individually inspected on arrival at the job site for integrity of the sealed ends and for physical injury (such as bends or flat spots). Pipes with lost seals or physical damage are to be re-cleaned or rejected.
c. Acceptable pipes are to be stored in a clean, safe location.
d. Quantities of pipe cleaned at any one time shall not exceed that which can be installed within the same working days. No pipe may be installed if the plastic bags on the ends of the pipe are not “puffed up”, which indicates a loss of the N2 charge.
e. Pipes, valves and/or fittings which do not comply with the cleaning standards (i.e. which show contamination at specified stages of the cleaning process) must be rejected and removed.

4. CHEMICAL SYSTEMS
A. Acid resistant drainage piping, if required, shall be FUSEAL for interior piping and Duriron for exterior piping.
B. Duriron exterior piping shall extend to the manhole outside the building.
C. Chemical drains shall run independently of the building system to a point outside the building before connecting to the building sewer.

5. DEIONIZED WATER SYSTEM
   A. Consult with the OSU Project Manager to select the type of reverse-osmosis (RO) unit to be used.
   B. Steam powered or electrically operated distillation units are not to be used.
   C. Use membrane filters rated for industrial service.
   D. Distribution piping:
      01. Shall be 80 CPVC piping with no dead ends.
      02. Shall include a continually recirculating system to provide necessary cleanliness.
   E. Piping shall be properly flushed, cleaned, and sanitized before being placed into service.
   F. Provide isolation valves at each floor, at each lab, and at each point of use.

Section 23 05 00 – COMMON WORK RESULTS

PART 1 GENERAL

1. HEATING AND COOLING LOAD CALCULATIONS
   - A. Heating and cooling design loads for the purpose of sizing HVAC systems shall be determined in accordance with one of the procedures described in the latest edition of the ASHRAE
   - B. Handbook of Fundamentals or equivalent computation procedures. The engineer shall furnish copies of applicable HVAC design calculations for review, along with periodic progress drawings.
   - C. Outdoor and indoor summer and winter design temperatures used in the building load calculations shall be as follows for the Corvallis campus:
     01. Summer Outdoor Design for Classroom Buildings: 92°F. db and 67 °F wb.
     02. Summer Outdoor Design for Laboratory Buildings: 96°F. db and 67°F wb.
     03. Summer Outdoor Cooling Tower Design for Classroom Buildings: 97° F. db and 73 °F wb. Condensing Water Entering water temperature: 95°F and leaving water temperature: 80°F
     04. Summer Outdoor Cooling Tower Design for Laboratory Buildings: 97° F. db and 73° F. wb. Condensing Water Entering water temperature: 95°F and leaving water temperature: 80°F.
     05. Summer Outdoor Air Cooled Condenser Design ≤ 10 tons 95° F.db, ≥ 10 tons 105° F. db.
     06. Summer Indoor Design Office: 76 ° F at the work station. No Humidification.
     07. Summer Indoor Design Classroom: 76° F. No Humidification.
     08. Summer Indoor Design Lab 73° F verify with the OSU Project Manager (PM). No Humidification.
     09. Winter Outdoor Design: 17° F, Wind @ 15 mph.
     10. Winter Indoor Design Office: 68°F at the work station. No Humidification.
     11. Winter Indoor Design Lab: 68° F at the work station. No Humidification.
     12. Winter Indoor Design Classroom: 68° F at the work station. No Humidification.
     13. Summer/Winter Indoor Design for other rooms as directed by the PM.

2. BUILDING ENVELOPE REQUIREMENTS
   - A. Design criteria listed below shall be used unless directed otherwise by the PM.
   - B. The proposed type of building envelope construction shall be designed using thermal transmittance values (U value), which comply with the the State energy Code requirement for thermal design.
   - C. To prevent energy waste, asll spaces with operatable windows must have window-HVAC interlocks to prevent HVAC system operation with windows open.
   - D. Equipment Loads

01. General offices: 0.5 watts per sq.ft.
02. Classrooms: 0.5 watts per sq.ft. or actual occupant load, with each occupant having a laptop computer, times 50%.
03. Labs: based on actual equipment load plus 20%.
04. Copy rooms: based on actual equipment load.
05. Computer rooms: based on actual equipment load plus 20%.
06. Corridors, walkways lobbies, etc.: None.
07. MDF rooms: based on actual equipment load.
08. IDF rooms: based on actual equipment load.
09. The PM will provide equipment loads for specific spaces when applicable.
10. When no specific data is available, use connected equipment electrical load (FLA) data with a 50% diversity factor.

E. OCCUPANCY LOADS
01. Minimum ventilation requirements based on latest edition of ASHRAE Standard 62.
02. Use actual planning data plus 10%. Refer to ASHRAE values of 250 BTUH per person.
03. General office: One person per 80 sq.ft.
04. Conference rooms: One person per chair plus 20%.
05. Labs: Base on one person per lab station.
06. Classrooms: Base on one person per seat.

F. LIGHTING LOADS
01. Minimum lighting loads based on NEC Table 220.12.
02. When a lighting designer is included as part of the project team base lighting loads on actual room by room lighting loads designed by lighting designer.

G. MINIMUM OUTSIDE AIR REQUIREMENTS
01. Minimum requirements based on latest edition of ASHRAE Standard 62 or the Mechanical Code.

H. NOISE CRITERIA
01. Open office space: RC 30-40.
02. Private offices: RC 25-35.
03. Conference rooms: RC 25-30.
04. Classrooms maximum: RC 35.
05. Laboratories: RC 35-45.
06. Halls, corridors, and lobbies maximum: RC 40.
07. Toilet and storage rooms maximum: RC-45.
08. Video Conference Rooms maximum: RC-25.

I. Provide for review a list of all pipe and duct systems with a brief justification of insulation and thickness, or of no insulation if none is specified.

J. Include all field insulated equipment on the list.

3. WATER SYSTEM REQUIREMENTS

A. General

01. Projects having total cooling requirements exceeding 50 tons of refrigeration should be designed around a central chilled system.
02. Hydronic systems design shall ensure that valves, control fittings and piping are of alloys which shall not deteriorate when subjected to the water treatment chemicals and are optimum for the piping and heat exchanger service. Provide a test port on discharge side of all pumps.
03. Locate mains and shutoff valves in hallways and corridors not in occupied rooms. Valves to be located within 18 inches of the main.
04. Consider routing main lines on the first floor to serve the first and second floors and mains located on the third floor to serve the third and forth floors of the building.
05. All hydronic systems shall be flushed of foreign materials, chemically cleaned, flushed, and filled with the proper chemically treated water before being put into service.
06. All closed loop water systems will have centrifugal air separator, bladder type expansion tank and make-up water connection connected as close as practical to the suction side of the circulating pump.
07. Make-up water supply components will have isolation valves and union connections to allow removal for servicing. The make-up water supply will be connected on the circulating pump suction near the expansion tank connection. The make-up supply will include include an isolation valve, a strainer, water meter, adjustable pressure regulator, safety relief and outlet check valve and isolation valve in that order. A valved by-pass line shall be provided around the make-up water assembly for initial system filling and emergency use. Provide ball valves in lieu of gate values for sizes 3-1/2” and smaller
08. All closed loop water systems will include a chemical addition tank with outlet filter, 2 each Aqua Pure H1P748 or equivalent, connected in parallel across the circulating pump to allow continuous online partial flow filtering.
09. All automatic vent devices must be provided with a manual isolation valve to allow replacement with system in operation. Devices with internal check valves are not sufficient to allow replacement with system in service.
10. When glycol feed tanks are provided the feed system pressure shall be digitally controlled and alarmed similar to the Advantage Controls model.

4. Water System Leakage Prevention
   A. All chilled water coils mounted within ductwork will have internal provisions to collect and drain condensation to prevent condensate transfer and leakage from ductwork.
   B. In addition to any internal drain collection features all chilled and hot water HVAC systems will be provided backup leakage prevention measures that will contain any water condensation or leakage from the HVAC coil and prevent system condensation or leakage from migration to lower levels.
   C. HVAC unit housings are not permitted to be installed directly to slab or other flooring without a drain pan or waterproof membrane protective shield to collect condensation or leakage and prevent migration
   D. Metal drain pans or berms with durable waterproof membranes will be provided under each AHU housings or coil to collect leakage when the coil or end turns are perforated
   E. Metal drain pans or berms will be alarmed to indicate leakage unless safe drainage is also provided.
   F. All condensate draings will be directly routed to floor drains. Condensate is not allowed to be pumped to the drain.

5. CHILLED WATER SYSTEMS
   A. Chilled water system flows and temperatures will vary based upon load, programming, scheduled or seasonal outages.
   B. New connections shall not be made to chilled water systems for the purpose of cooling process equipment or condensing units without the approval of the Energy Operations Manager.
   C. The primary-secondary pumping system arrangements for variable flow are to be used whenever possible.
   D. Multiple chillers are to be connected in parallel on the primary loop with each chiller served by a dedicated primary pump.
   E. Primary pump redundancy, if required, shall be provided by cross-connection lines with manual isolation valves and a stand-by pump.
   F. Secondary pumping redundancy shall be provided with a stand-by pump.
   G. Provide variable flow pumping schemes for secondary chilled water distribution loops.
   H. The primary loop piping to each chiller shall be provided with a flow measurement device such as a Venturi meter or Annubar unit, pressure gauges, industrial quality thermometers and thermowells and “Pete’s Plug” test points. Similar instrumentation shall be installed on secondary supply piping circuits.
   I. All chilled water coils will be provided duct drip pans internal to the ducting to collect and drain condensation.
   J. Design chilled water systems using schedule 40 black steel pipe on larger sizes and type L copper for smaller sizes.

K. Fittings can be either, soldered, welded, flanged, threaded, or Victaulic type connectors depending on the pipe size.

L. Chilled water piping systems
   01. Pressure drop: 4 ft. w.c. per 100 ft.
   02. Maximum velocity
   03. Mains (equipment rooms): 10 ft. pr sec.
   04. Mains and branches (other areas): 5 ft. per sec

M. Chilled water system design temperature
   01. Chilled water: 16 - 20°F temperature difference

6. HEATING WATER SYSTEM

A. Two types of piping and equipment arrangements shall be used.
   02. A one heat exchanger system shall have a pair of pumps connected in parallel, each sized for full load and located downstream of the heat exchanger. One pump shall be a spare and they both shall pump into the primary loop.
   03. If two heat exchangers are used, they shall be piped in parallel and connected to a common suction header connecting the pumps.

B. Size single heat exchanger systems for the load. Size multiple heat exchanger systems so that each heat exchanger is sized for 75% of the load.

C. The primary loop piping to each heat exchanger shall be provided with a flow measurement device such as a venturi meter or annubar unit, pressure gauges, industrial quality thermometers and thermowells and “Pete’s Plug” test points. Similar instrumentation shall be installed on secondary supply piping circuits.

D. Hot Water System Design
   01. Design heating water systems using schedule 40 black steel pipe on larger sizes and type L copper for smaller sizes.
   02. Fittings can be either, soldered, welded, flanged, threaded, or depending on pipe size.
   03. Hot water piping systems
   04. Pressure drop: 4 ft. w.c. per 100 ft.
   05. Maximum velocity
      a. Mains (equipment rooms): 10 ft. per second
      b. Mains and branches (other areas): 5 ft. per second
      c. Hot water system design temperature
         1. Heat Exchangers: 40 - 60°F temperature difference
   06. Main coils: 20°F temperature difference
   07. Re-heat / fan coils: 10°F temperature difference

7. CONDENSER WATER SYSTEM

A. Condenser water systems shall be designed with a pump and cooling tower for each chiller or with multiple (at least two) pumps located to discharge to a common pipe manifold with piping redistributed to each chiller. The designed

system shall to minimize life cyles costs to the maxiumum extent practical while emphasizing energy efficiency.

B. Tower systems designs shall consider the following criteria:
   08. Design temperatures for Outdoor and Condensing Water systems as specified in these standards.
   09. Water filtration.
   10. Water treatment.
   11. Open circuit versus closed circuit cooling towers.
   12. Sound and noise with respect to surroundings.
   13. Energy consumption.
   14. Capacity control utilizing variable frequency drives. Consider valves to proportionally control the water flow through a by-pass line to the tower basin when chillers are to be utilized and condenser water temperatures could be below 65 deg. F.
   15. Vibration isolation, including upper limit stops.
   16. Location of pumps and piping to ensure flooded suction on the pumps to prevent possible cavitation.
   17. Basin and make-up water heaters.
   18. Fire resistance of the tower components.
   19. Control of the tower water flow through the chillers as they are cycled on and off.
   20. Electric heaters or steam coils in the basin, for freeze protection.
   21. Insulate and heat trace exposed cooling tower condenser piping.

C. Condenser water system design
   01. Design condenser water systems using schedule 40 black steel pipe.
   02. Fittings can be either welded, flanged, threaded, or Victaulic type connectors depending on pipe size.
   03. Provide a minimum of 20% extra tower capacity (BTUH, Flow, CFM) for future growth.
   04. Provide VFD for capacity control.
   05. Cooling tower piping systems
      a. Pressure drop: 4 ft. w.c. per 100 ft.
      b. Maximum velocity
      c. Mains equipment rooms: 10 ft. per sec.
   06. Condenser water design temperatures
      a. Design dry bulb: 97° F .
      b. Design wet bulb: 73° F.
      c. Entering water temperature: 95°F.
      d. Leaving water temperature: 80°F.

8. DIRECT EXPANSION REFRIGERANT

A. Systems may be:
   01. Single package for single zone applications.

02. Single package for multi-zone-zone application.
03. Split system air-cooled condenser/evaporator for cooling air or water.
04. Split system water-cooled condenser/evaporator for cooling air or water.

B. Systems shall be used where the life cycle is cost effective. If the system exceeds 50 tons, air cooled chillers may be considered for single unit with one per air handler for air handlers up to 400 tons. One air cooled chiller for multiple air handlers up to 50 tons each. Obtain approval from the PM prior to designing the system incorporating such features.

C. Direct Expansion Refrigerant System
01. Design refrigerant systems using type L copper.
02. Fittings to be copper to match piping, and brazed using a nitrogen purge.
03. Size is based on manufacturer's recommendations.

D. Decommissioned refrigerant containing equipment shall display a weather resistant label clearly noting the removal of all hazardous materials, e.g. refrigerant, coolant, used oil, or any other hazardous material removed form unit.

9. LABELING AND IDENTIFICATION

A. Color Coding of Pipe and Duct Labeling

Color Coding of Pipe and Duct Labeling		
Classification	Color of Field	**Color of Letters**
Materials Inherently Hazardous		
Flammable or Explosive	Yellow	Black
Chemically Active or Toxic	Yellow	Black
Extreme Temperatures or Pressures	Yellow	Black
Radioactive	Yellow	Black
Materials of Inherently Low Hazard		
Liquid or Liquid Admixture	Green	White
Gas or Gaseous Admixture	Green	White
Fire Quenching Materials		
Water, Foam, CO2, Halon, etc	Red	White
Line Labeling		
Steam	Yellow	White
Condensate	Yellow	Black
City Water/Domestic Water	Green	White
Supply Gas (any piping)	Yellow	Black
Air	Blue	White
Industrial Water	Yellow	Black

B. Identification of Concealed Valves and Equipment

01. Affix a color coded “dot” to walls or ceilings wherever valves or other equipment are concealed. The colors shall be as follows:

Fire Protection	Red
Domestic/Non Potable CW	Green
Domestic/Non Potable HW	Yellow
HVAC Valving & equipment	Blue
HVAC Fire, Smoke, or Combination Fire/smoke dampers	Red
Plumbing Cleanouts	Black
Lab piping	Purple

C. Identification of Equipment, Pipes, and Ducts

01. All plumbing, heating, air conditioning, piping, automatic temperature control equipment (excluding thermostats and relays), and distribution systems shall be labeled. Electrical switches and starters for mechanical equipment shall also be labeled.
02. Equipment labels shall be black face plastic laminate with white engraved letters 3/16" high or larger, and shall be attached securely.
03. Equipment nameplates shall include the following information at a minimum:
    a. Plan identification.
    b. Capacity specified at designed operating conditions.
    c. Actual capacity as balanced at site operating conditions.
    d. Area or zone served.
    e. All new installations of evaporator coil housing and condenser units shall have tags that states who installed the unit, a warranty contact phone number and warranty date, start to finish.

10. PIPING

A. All valves within the building, regardless of size and location, shall have brass or stainless steel tags at least 1" by 3" or two inch diameter in size and 0.051 inches thick. Lettering on the tag shall be engraved or stamped at least 3/16 inch high and match the valve numbers shown on the plans.

B. Valve tags shall be connected to valve stems by steel rings and include the following minimum information:

01. Plan Identification
02. Normal Position
03. Duty
04. Area Served
05. Valve Type

C. Heating Water Valves, Steam Valves, and all Valves located in the secondary (low pressure) side of HTW Heat Exchangers shall include the Manufacturer, Size, Grade, and Pressure-Temperature service rating.

D. Valve Tag Directory: Include tag number, location, exposed or concealed, service, valve size, valve manufacturer, valve model number, tag material, and normal operating position of valve. Include valve tag directory in the Operation and Maintenance Manuals and framed under glass on wall of mechanical room.

E. All piping systems shall be properly identified with labels and signs indicating direction of flow and fluid. Identification shall be specified to have identification as outlined in the ASME(ANSI) Standard and current NFPA requirements. Provide a list of each system being installed with the appropriate name and label colors in the specifications.

F. Comply with OSPSC Section 1003(r) regarding identification of non-potable piping systems.

G. All accessible piping shall be color coded and identified with wording and arrows every 20 feet on straight runs, at each riser, at each junction, at each access door, adjacent to all valves and, flanges, on both sides of floor and wall penetrations and where required to easily identify the medium transported.

H. Provide a trace wire for locating and identifying underground piping systems in the future.

I. Provide marker tape one foot above the top of underground piping over the entire length of the pipe.

11. AIR SYSTEM REQUIREMENTS

A. General

01. This section's purpose is to establish standards of quality and utility for the mechanical components. The engineer's task is to utilize equipment that provides the best value and lowest lifecycle cost while conforming to these standards.

02. The quality of items not covered in these standards shall be of the same general level and be subject to the same tests of value as those that are included.

03. Select items made by established manufacturers who have demonstrated the capability to provide replacement parts and service as may be required. The quality of the manufacturer's local representation is very important.

04. Analyze manufacturers' designs for inherent maintenance qualities, as well as adequate access doors, fasteners, and other accessories, which will facilitate maintenance.

12. EQUIPMENT ACCESS AND LOCATION

A. Ease of operation, maintenance and repair, and safety of personnel are primary considerations for the design and installation of all items. Design for a minimum

of 4 feet of clearance all around major items such as boilers, chillers, pumps, air handlers and fans unless the manufacturer's recommendations or code requirements are greater.

B. No equipment shall be installed in locations that will prevent future removal without major disruptions to the building or its contents. All equipment selected shall be designed for and provided with access doors and other accessories to address the requirements of this section. Connecting systems such as ductwork, piping, and electrical conduit shall be located so they do not obstruct access to the equipment service points.

C. Provisions shall be made to allow easy access for hoisting heavy or cumbersome equipment onto elevated mechanical spaces.

D. Critical wear components such as bearings, fan shafts, couplings, and belts shall be easily replaceable. Frequent service items shall be convenient; for example, easy access to filters and extended lubrication fitting.

E. Equipment shall be designed so access doors, panels, guards, and similar items can be removed and replaced without special tools, so they are sturdy enough not to sustain damage under normal use and care.

F. Provisions shall be made to provide a penthouse enclosure for rooftop equipment, when deemed suitable by the OSU Project Manager.

13. SOUND AND VIBRATION

A. Consider all appropriate sources of concern including radiated energy, energy transmitted through connecting items such as supports and electrical conduit, and energy transmitted through ducts, pipes and the fluids carried in them.

B. Select equipment and specify isolators and attenuators to eliminate undesirable sound and vibration levels. Obtain approval for the design criteria from the OSU Project Manager. If the design criteria is not established by a acoustical consultant use the following specifications:

01. Vibration: Eliminate vibration which will be detrimental to the structure, its contents, or the activities taking place within the structure, or which would be annoying to the occupants.

02. Sound: The operating systems should conform to the recommendations listed in the latest edition of the ASHRAE Handbook.

03. Documentation: Provide documentation, for all office, conference room, classrooms, labs, and mechanical equipment areas showing actual sound levels at the project's close-out.

14. SEISMIC REQUIREMENTS

A. HVAC systems, equipment, and parts shall meet or exceed current applicable requirements for seismic resistance specified by codes, regulations, or agencies having jurisdiction.

15. VARIABLE SPEED/FREQUENCY DRIVES
    A. Drives and motors shall be specified to be provided by the same vendor to provide single source responsibility.
    B. Shaft to frame voltage difference shall be specified to be 3 volts or less to reduce the potential of bearing pitting to a minimum.
    C. Shaft grounding or bearing isolation shall be provided as directed from the OSU Project Manager.
    D. See Electrical section for additional requirements.

16. BELT DRIVES
    A. Specify multi-belt, adjustable speed drives rated at 150 percent of motor horsepower for constant speed motors which are 15 horsepower and smaller.
    B. Specify fixed pitch drives rated at 150 percent of motor horsepower for constant speed motors larger than 15 horsepower.
    C. Adjustable pitch drives shall operate at or near the midpoint range of adjustment when the equipment is balanced to the specified performance.
    D. Belt drives shall have fully enclosed guards. Outdoor guards shall be of solid metal construction; indoor guards shall be of expanded metal set in angle iron frames. Guards shall be constructed in two pieces to allow for belt and sheave adjustment without disturbing the guard supports. Specify 4" diameter tachometer holes with pivoted cover plates at each shaft. Guards shall comply with applicable codes.

17. ELECTRIC MOTORS
    A. Electric motors shall have sufficient starting torque to start and drive the equipment load to which they are connected. Motors shall be of the premium-efficiency type conforming to the latest State Energy Code requirements.
    B. Provide insulated motor bearings or shaft grounding on motors connected to variable frequency drives.
    C. Motor enclosures shall be:
        01. Drip-proof for general use.
        02. Totally enclosed, fan-cooled (TEFC) for wet or exterior use.
        03. Totally enclosed, air over (TEAO) for cooling towers.
    D. Motor voltages shall be:
        01. 1/2 HP or less: 120V,1 phase.
        02. ¾ HP or greater: 460V, 3 phase.
    E. See Electrical section for additional requirements.

18. BEARINGS
    A. Bearings shall be selected for a minimum of 200,000 hour or L-10 life expectancy, 400,000 hour preferred.

19. WEATHER PROTECTION
    A. Products installed exposed to the weather, moisture, or other potentially damaging conditions shall have their joints effectively sealed to prevent intrusion of moisture or other unwanted substances. Consider the use of heater in control panels and other items that could experience internal condensation. Tops of cabinets and equipment enclosures shall be designed to prevent puddling of liquids.

20. EQUIPMENT SELECTIONS
    A. Select the type of equipment best suited for the specified project requirements considering performance, flexibility, noise and vibration level, quality of construction, cost of ownership, and energy consumption.

21. UNIVERSITY PREFERRED HVAC EQUIPMENT WITH STOCKED PARTS:

Air compressors	Quincy	PRV's	Spence
Bearings	Fafnir	R.O.s	Culligan
BFPs	Febco	Radiator Thermostat Valve Controls	Danfoss
Condensate Pumps, Tanks	Paco	Refrigeration Compressors	Copeland
Couplings	Lovejoy	Utility Set and Skycap Fans	Pace
Motors, Pumps	Industrial Grade	Comp. Air Filters	Finite Filters

22. MEDIA ACCESS CONTROL ADDRESS
    A. Specify that the media access control (MAC) Address (Hardware address that uniquely identified the device node) for equipment (chillers, boilers, VFD's etc.) that needs an Ethernet connection, is clearly written on the inside of the equipment control panel at the time the equipment ships from the factory.

23. AIR AND WATER BALANCING
    A. Systems testing, adjusting, and balancing is the process of checking and adjusting all the building environmental systems to produce the design objectives. It includes:
    B. The balance of air distribution
    C. Adjustment of system to provide design quantities
    D. Electrical measurement

E. Verification of performance of all equipment and automatic controls
F. Air Balancers must be registered engineers in the State of Oregon and have at least 3 years of testing, adjusting, and balancing experience similar to that required for OSU's project. The Balancing contractor and project supervisor shall be NEBB or AABC Certified.
G. NEBB: National Environmental Balancing Bureau
H. AABC: Associated Air Balance Council
I. Mark equipment settings, including damper control positions, valve indicators, fan speed control levers, and similar controls and devices, to show their final settings. Mark with paint or other suitable, permanent identification materials.

24. PIPING MATERIALS

Chilled Water	Heating Water	Condenser Water	Steam	Condensate	Material
X	X	X			ASTM A53 Schedule 40 black steel with ANSI B16.1 malleable iron fittings; ANSI B16.5 flanged fillings; ANSI B16.9 steel bevelweld fittings.
X	Certain locations; see note 1.	X			Steel grooved end fittings: Victaulic or Guston-Bacon full flow using vitaulic 07 or Guston-Bacon #105 gasket for 500 psi service.
X	X	X			ASTM B88 Type L copper above ground with ASSI B16.22 wrought copper fittings with 95%-5% tin-antimony solder joints.
			X		ASTM A53 Schedule 40 black steel with 150 pound rated valves and fitting; ANSI B16.3 malleable iron threaded fittings; ANSI B16.5 flanged fittings; ANSI B16.9 steel bevelweld fittings.
				X	ASTM A53 Schedule 80 black steel with 150 pound rated valves and fitting; Joints <2" threaded except welded in shafts or inaccessible spaces ANSI B16.3 malleable iron threaded fittings; ANSI B16.5 flanged fillings; ANSI B16.9 steel bevel welding fitting. Joints >2-1/2" ANSI B16.25 belvelweld, ANSI B16.5 flanges, or B16.11 socket weld.

Note 1: Steel grooved and fittings allowed on heating water systems in exposed areas only. Maximum of 180 degree F. water temperature.

25. MANUFACTURERS

A. Piping

Chilled Water	Heating Water	Steam	Item	Brand or Company
			Moved to Section 23125, Steam Distribution.	
X	X	X	Control Valves	Honeywell or Johnson
		X	Cross connection devices (preferred)	Febco
	X	X	Thermostatic control valves and stats	Danfoss
		X	Trap	Armstrong 800
		X	Trap (floats & thermostats)	Hoffman
X	X	X	Rising stem valves	Stockham/ Grinnel
X	X	X	Valves, ball	Apollo
X	X	X	Valves, brass ball	Gem
X	X	X	Valves, gate	Nibco
X	X	X	Valves, pressure	Watts
X	X	X	Valves, pressure regulating	PRV Spence
X	X	X	Valves, rising stem valve	Stockham/ Grinnel

B. Air Handling Equipment

01. Fans - general: Barry Blower, Twin City, Greenheck, Peerless, Cook.
02. Fans – Fume Hoods: Plasticare
03. Central Station Air Handling Units: Hunt Air, LogicAir, Haakon.
04. Package Rooftop Air Handlers: Carrier, Trane McQuay.

C. Chilled Water Equipment

01. Chillers: Carrier and Trane.
02. Pumps: Bell & Gossett, TACO, PACO.
03. Inline pumps Bell & Gossett Series 60 or 80.

D. Cooling tower: Baltimore Air Coil, Evapco. Provide a sewer deduction meter for cooling tower make-up water. Meter specifications found in Section 33050 – Meters.

E. Heating Water Equipment

01. Steam to hot water heat exchangers: Aerco, Armstrong, Patterson-Kelley.
02. Direct buried steam and condensate piping: Rovanco, Thermacore.
03. Condensate Pumps: PACO, Bell & Gossett maintenance free type
04. Water Treatment: Chem Aqua.
05. Steam meterinformation is found in section 33050 - Meters.

26. FUEL BURNING EQUIPMENT – PARTICULATE EMISSIONS

Particulate matter emissions from any fuel burning equipment installed, constructed, or modified after June 1, 1970 must not exceed 0.1 grains per standard cubic food, corrected to 12% CO_2 or 50% excess air. "Fuel Burning Equipment" means a device that burns a solid, liquid, or gaseous fuel, the principal purpose of which is to produce heat or power by indirect heat transfer. Particulate emissions for backup emergency generators is $\leq$ 0.1 grain/ft^3 (for new sources) or $\leq$ 0.2 grains/ft^3 (for existing sources).

Section 23 05 13 – MOTORS AND STARTERS

PART 1 – GENERAL

1. REQUIREMENTS
   A. Motor Bearing Protection: Motors connected to variable frequency drives (VFD) shall have their bearings protected from the effects of metal removal caused by current flow. Protection shall be any of the following methods:
      01. Externally applied electrical shunt between the motor frame and shaft. Shaft Grounding Systems or approved.
      02. Electrically insulated bearings rated for the mechanical and electrical application. Electrical resistance shall be sufficient to prevent current flow, including current flow from "skin effect", induced by VFD.
   B. All electric motors shall be high efficiency motors, 3 horsepower and larger to be 3 phase motors rated for inverter duty.
   C. All 7.5 HP motors and larger shall use soft starts or variable frequency drives to start the motor, except for continuous use motors (motors that run at 100% - exception on approval of the OSU Electric Shop).
   D. All starters shall use standard heaters, to determine motor current and overload trip conditions. (Exceptions: for phase failure and over/under voltage conditions, electronic overloads may be permitted on approval of the OSU Electrical shop.)
   E. Self-protection and Reliability Features:
      01. Input transient protection by means of surge suppressors.
      02. Snubber networks to protect against malfunction due to system voltage transients.
      03. Notch filter to prevent operation of the controller-motor-load combination at a natural frequency of the combination.
      04. Loss of Phase Protection.
      05. Reverse Phase Protection.
      06. Under- and Over-Voltage Trips.
      07. Over-temperature Trip.
      08. Short Circuit Protection.
         a. **Automatic Reset/Restart:** Attempt 3 restarts after a controller fault or on the return of power to the system following an interruption and before shutting down for manual reset or fault correction. Provide for restarting during deceleration without damage to the controller, motor, or load.
         b. **Power interruption Protection:** Prevent motor reenergizing after a power interruption until the motor has stopped.
   F. Programming:
      01. The operator shall have the ability to program drive with a computer link e.g. RS-232 or approved.
      02. A back-up program and software shall be provided.

03. Toshiba, Cutler Hammer, ABB, Square D, and GE are approved manufacturers for all motor starter, soft starts, and VFD's. All drives will be supplied with manufacturer's approved magnetic bypass.
04. OSU personnel are to be provided appropriate levels of on-site training for new equipment or new technology.

Section 23 07 13 – DUCTWORK INSULATION

PART 1 – GENERAL

1. REQUIREMENTS
   - A. Provide for review a list of all pipe and duct systems with a brief justification of insulation and thickness, or of no insulation if none is specified.
   - B. Include all field insulated equipment on the list.
   - C. As a minimum nsulation thickness to meet the requirements of the State Energy Code.

2. MATERIALS
   - A. The insulation and jacketing shall be resistant to moisture and mold and shall be resistant to damage or deterioration under the service intended. Materials shall meet the smoke and flame spread ratings required by the governing codes.
   - B. Closed cell plastic insulation is preferred on refrigerant piping and cold equipment.

3. EXPOSURE
   - A. Surfaces, which will operate within 10 deg. F of the ambient dew point, shall have a vapor barrier over the insulation.
   - B. Surfaces better than 90 deg. F shall be insulated as required to protect personnel and/or conserve energy.
   - C. Insulation exposed to weather or to physical damage shall have suitable protection.
   - D. Aluminum jackets secured with aluminum bands on 12" centers with longitudinal seams lapped and turned down shall be installed on all piping exposed to weather. Provide similar protection at all valves, fittings, and flanges.

4. SERVICE
   - A. Insulation shall be installed such that service and maintenance points such as valve handles, access doors, pressure and temperature fittings, lubrication fittings, and strainers remain accessible without disturbing the insulation.
     - 01. Vapor barrier jackets shall be sealed at locations to prevent the intrusion of moisture.

5. PIPING
   - A. Use factory made PVC covers at fittings, flanges, and all other irregular shapes for which they are available.
     - 01. Specify structurally rigid insulation sections at all hangers and supports to prevent damage to the insulation and jackets.
     - 02. Size hangers and supports to go outside the insulation.

03. Provide steam traps 1” and over with snap on insulation. See Section 23125 for additional steam system insulation requirements.

6. DUCTWORK
   A. Provide a vapor seal design at strap or rod hangers and a thermal conduction barrier at trapeze hangers and supports.
   B. Require extra erosion protection at the upstream edge of duct lining sections such as a sheet metal flashing.
   C. Internally lined ductwork
      01. Internally lined ductwork shall be avoided, except when used for sound attenuation or when used in areas where external insulation is subject to damage (such as mechanical rooms).
      02. Where internal insulation is used provide Mylar facing to allow cleaning.
      03. Provide perforated liner over internal insulation inside mechanical units.
   D. Access will be provided at elbows, turning vanes, and locations where debris collects.
   E. Other sound isolation is anticipated when the insulation is external.
   F. Use a maximum of six feet of flexible ductwork on diffuser and grille run outs.

7. EQUIPMENT
   A. Coordinate insulation and equipment specifications to be sure that the required insulation is field applied if equipment is not factory insulated.
   B. Equipment such as chilled water pumps or heat exchangers which must be completely insulated shall be provided with boxed insulation which is designed and marked so it can be removed and replaced without destroying the utility and appearance, except for repairs needed on the jacket.

Section 23 20 00 – FLUID SYSTEMS EQUIPMENT

PART 1 – GENERAL

1. CHILLERS

A. Provide chiller packages with centrifugal compressors, or screw compressors, and water cooled condensers.

B. Design the chiller plant with at least two chillers if the total capacity is more than 400 tons. Size one chiller for 1/3 of the load and the other chiller for 2/3 of the load.

C. Include equipment KW/Ton and APLV values in a selection criteria.

D. Basic Equipment Requirements

01. The equipment shall be furnished as a complete factory assembled package, including hermetically sealed compressor, variable speed drive and motor, evaporator, condenser, lubrication and purge systems, capacity controls, instrumentation and control panel, power and control wiring, refrigerant piping, full charges of R-123, R-134a, or R-22.

02. The control package on the chiller must be capable of controlling chilled and condenser water pumps, the cooling tower, and interface to the building automation system via the BACnet or LON control protocols.

03. Chiller room ventilation is required in accordance with the Uniform Mechanical Code and ASHRAE 15. Include refrigerant sensors, control systems, and air handling equipment in any existing chiller rooms to be upgraded to bring them in full compliance with current codes.

04. The equipment shall be rated in conformance with the latest ARI Standard 550-88 and shall conform to the latest ANSI/ASHRAE 15 Safety Code.

05. The condenser and evaporator shall also conform to the ANSI B9.1 Safety Code for mechanical refrigeration and to the ASME Code for Unfired Pressure Vessels where applicable.

06. Electrical components and assemblies shall bear the UL or ETL label, where applicable, and electrical requirements, including control requirements, must be coordinated with available utilities.

07. The starter may by unit mounted or free standing, but shall be designed specifically for the characteristics of the chiller and shall be furnished with the chiller by the chiller manufacturer.

08. The temperature control system shall be provided with interface devices and a terminal block to allow remote adjustment of the chilled water temperature set point.

B. Performance requirements

01. Equipment selection, including evaporator and condenser size and configuration, shall be based on the chilled water system requirements.

Coordinate the choice of chillers and system requirements to provide the optimum selection of equipment vs. flow rates, temperatures and temperature changes.

02. Provide computerized analyses from the manufacturer for at least three different selections. Data should include part load performance in kW/ton based on ARI 550 test conditions, including condenser water relief in 10% increments from 10% to 100% of machine capacity. Base selections on 0.0005 fouling factors for both the evaporator and condenser.

2. COOLING TOWERS

A. Specify that cooling towers shall not be filled until chemical treatment is operational and that only treated water shall be used in the system.

B. Isolate the cooling tower from all pipe flushing and cleaning operations.

C. Use only induced draft cross flow cooling towers located on the roof of the building. Forced draft cooling towers and cooling towers located at grade are not acceptable to OSU.

D. Towers shall be constructed of non-combustible materials.

E. Cooling towers to be selected for maximum efficiency at the selected operation point and are to be sized for an additional 20% capacity.

F. Equalizer connections between basins shall be specified on multiple open evaporative tower applications. Equalizer connections and piping between tower basins shall be separate from any other piping systems. Evaluate the impact of sound upon surroundings.

G. Basic equipment requirements

01. Cooling towers shall meet the following minimum criteria:

a. The towers shall be factory assembled, induced draft, cross flow type with a vertical air discharge.

b. The basin and casing up to the top of the fill shall be constructed of 304 stainless steel.

c. The casing above the fill shall be constructed entirely from hot-dip galvanized steel panels supported by a hot-dip galvanized steel angle and channel framework, all finished inside and out with zinc chromatized aluminum. Consider fiber reinforced plastic and stainless steel construction.

d. The basin shall have a connecting weir for equalization of water level and a by-pass connection. A brass, float-operated make-up valve shall be provided complete with a large diameter plastic float, arranged for easy adjustment. The float valve is to be sized for the worst possible conditions of basin fill rate.

e. Basins shall be provided with provisions for a winter bypass to the sump when the system is expected to operate during winter conditions.

f. Basins must have a bottom outlet with a strainer and an anti-cavitation device. Do not select a side outlet configuration.
g. Inlet louvers shall be of fiberglass or galvanized steel construction, and equipped with inlet screens.
h. The fill material shall be PVC and have a flame spread rating of 5 per ASTM Standard E84-77A and shall be impervious to rot, decay, fungus, or biological attack.
i. Drift eliminators shall be constructed of PVC and shall limit drift to less than 0.2 percent of the total water circulated.
j. Fans shall be a fixed pitch, heavy duty, cast aluminum, multi-blade type, protected by a fan guard and each driven though a gear box or power belt reducer by a TEAO (totally enclosed, air over), 1800 RPM, motor, ball bearing type designed specifically for cooling tower service. The motor shall be the high-power factor and high-energy efficient type and have non-fused disconnects located at the motor. The motor shall be furnished with special moisture protection windings, shafts, and bearings. The fan and shaft shall be supported by re-lubricatable ball bearings with special moisture seals, slingers, and housings designed to prevent moisture accumulation. Provide a vibration cut-out switch.
k. Access doors shall be provided on both sides of the tower for access to eliminators and the plenum section. Safety railing and a ladder shall be furnished with a tower unit requiring a fan and drive service above the fan deck, and shall meet OSHA requirements. Units capable of being serviced from within the unit shall be provided with an internal galvanized steel catwalk for service access.
l. Lubrication points are to be provided with piping or tubing extensions to readily accessible points and terminate with appropriate lubrication fittings.
m. Furnish electric immersion heaters or steam heaters (preferred), factory installed to prevent freeze-up conditions (where it is appropriate.) Include factory installed thermostats and controllers.
n. Furnish vibration isolator rails for vibration control. Consult with the sound consultant for requirements.

3. PUMPS
   A. Specify single stage centrifugal pumps for water service.
   B. Horizontal, base mounted, end suction pumps with a common forged or cast, steel base frame (not welded), are preferred for applications up to 1,000 GPM.
   C. Horizontal or vertical split case pumps with a common steel base are preferred for applications larger than 1,000 GPM.

D. Select the pump motor horsepower for non-overloading conditions.
E. Small circulation pumps must be a maintenance free type.
F. Pipe mounted pumps must have a cast iron volute.
G. Basic equipment requirements
   01. All water service pumps shall be of bronze fitted cast iron with mechanical seals of the carbon-ceramic type.
   02. Impellers shall be bronze, enclosed, statically and dynamically balanced, and fitted to the shaft with a key and locked in place. Motors and impellers shall be easily removed without disassembling the piping.
   03. Specify 1,750 RPM motors. Avoid using 3,500 RPM motors. Motors shall be the premium-efficiency type. Pumps, coupling, and motors shall be factory installed.
   04. The pump shaft shall be fitted with a bronze sleeve and the bearing frame assembly shall be fitted with regreasable ball bearings.
   05. The end suction or split case pump and the motor shall be connected with a flexible coupler fitted with an OSHA approved coupling guard. The pump housing shall have gauge and drain tappings.

4. PUMP SUCTION DIFFUSERS
   A. Suction diffusers should be considered for all chilled and hot water system pumps with capacities up to 2,500 GPM.
   B. Basic equipment requirements
      01. The unit shall consist of an angle type body with inlet vanes and a combination diffuser-strainer-orifice cylinder with 3/16" diameters openings for pump protection.
      02. The orifice cylinder shall be equipped with a disposable fine mesh strainer which shall be removed after system start-up.
   C. A permanent magnet shall be located within the flow stream and shall be removable for cleaning.
   D. The unit shall be provided with an adjustable support foot to carry the weight of the suction piping.

5. EXPANSION TANKS
   A. Pressurized diaphragm type, pre-charged with air to the initial fill pressure of the system shall be located on the suction side of circulator pumps. The tank shall be ASME stamped and certified for 125 psi and 240 deg. F. Furnish horizontal tanks with saddles and vertical tanks with base mounts.

6. STRAINERS
   A. Specify strainers in all hot water, chilled water, steam, and condenser water systems. Provide manual blow-down valves for strainers in sizes 1 1/4" and larger. Provide Y-type strainers at water supply piping to all chilled water and hot water coils, upstream of all components except the last isolation valve. Size

the mesh for service. Provide valving, and allow space to remove and clean the strainer basket or mesh.

B. Use Y-type strainers for up to 8" diameter. For larger sizes, use basket-type strainers.

7. WATER FLOW MEASURING STATIONS
   A. Use a pitot tube or Venturi type and specify stations complete with a portable readout meter. Locate the meter in the piping at a point where proper upstream and downstream distances are observed so that accurate readings can be obtained. Differential pressure taps for the meter readout shall be located on the horizontal centerline of horizontal pipes.
   B. Specify stations with shut-off valves and quick disconnects for the portable meter.

8. AIR SEPARATORS
   A. Specify air separators in all hot and cold water closed loop systems.
   B. Air separators shall be the centrifugal type complete with removable strainers, drains and support legs or brackets.
   C. Provide an automatic air vent with separator assemblies.

9. TEST PORTS
   A. Specify a "Petes Plug" to be installed in piping at the inlet and outlet of all water coils, heat exchangers, chillers, pumps, and at all ports of water coil temperature control valves.

10. WATER TREATMENT
   A. Water treatment systems shall be provided for all open circulated systems requiring a continuous supply of make-up water. The chemical treatment system shall be automatic in operation and shall continuously monitor and control pH, conductivity, and the corrosive tendency of the recirculated water. Chemicals shall come in a solid concentrated form and be specifically formulated for the water on the OSU campus.
   B. All closed loop chilled water and hot water circulating systems shall be provided with chemical feeders across the appropriate pumps.
   C. Basic equipment requirements
      01. Specify that system components are to be furnished by a single supplier. Components shall include, but not be limited to, the following:
         a. A pre-wired control and instrumentation panel mounted in a NEMA 12 enclosure with a key-lock door with a window.
         b. A water meter for monitoring make-up water quantity.
         c. An automatic bleed valve.
         d. Sensor assemblies.
         e. Chemical feed pumps (positive displacement type).

f. Corporation stop and injection assemblies.
g. Chemical feeding tubing.
h. Solid concentrated chemical.

D. Acceptable manufacturers: Chem Aqua, or an equal.

11. PIPING

A. Standards

01. The piping systems shall be designed in accordance with the guidelines established by the latest edition of the ASHRAE Fundamentals Handbook.

12. QUALITY ASSURANCE

A. Welders must be certified in accordance with the American Welding Society Standard Qualification Procedures.

B. Refrigerant piping installers must be certified by the American Refrigeration Contractors Association Qualification Procedures.

C. A factory trained representative of special items or systems must provide field instruction to the installers.

13. ROUTING

A. The piping shall be routed as directly as possible and sloped for venting and draining. Where possible, use routing to accommodate thermal expansion requirements. Locate pipes, vales, and accessories to be readily observable and accessible for modification, maintenance, or repair, except when concealed in finished areas.

14. LAYOUT

A. Piping runs, manifolds, and connections to equipment should be arranged so the operation and function of the systems and their components are easily understood.

15. CONNECTIONS TO EQUIPMENT

A. Arrange pipe, valves and accessories for ease of operation and maintenance. Every item of equipment and every assembly such as pressure reducing stations and flow control/measuring stations shall be provided with isolation valves; a balancing valve equipped with a memory stop may be used as the downstream valve if appropriate. By-pass loops with balancing valves shall be provided where it is desirable to keep the system in operation during shutdown.

B. Flexible connections shall be provided at equipment to allow for minor misalignment. Vibration elimination connections shall be provided where required. Rigid pipe supports shall be provided on the "outboard" side of flexible connections and vibration eliminators. Avoid strain on equipment.

C. Provide clear access to all heat exchanger bundles of chillers, boilers, heat exchangers and coils for cleaning, removal or replacing individual tubes. Route

connecting piping to clear access space or provide flanged connections to allow minimal removal of piping to gain clear access. In general, the clear access shall be provided at one end only of the heat exchanger bundle.

16. THERMAL EXPANSION
    A. Where it is not possible to accommodate expansion and contraction by the general routing of the pipe, expansion loops or expansion devices must be used.
        01. Take special care in providing for adequate expansion.
        02. Proper pipe guides are imperative at expansion loops and devices.
        03. Loops or flexible sections are preferred over mechanical joints.
    B. Locate properly designed anchors that control the way expansion occurs to ensure the effectiveness of routing, loops, or devices and to prevent undesired movement at connections to equipment, where pipes are close to structure, etc.
    C. See paragraph 10, calculations, in the Responsibilities of the Mechanical Engineer section.

17. VENTING AND DRAINING
    A. Piping shall be pitched to allow for proper automatic venting of all system high points and manual or automatic draining of all system low points. Use eccentric reducers as required. Provide manual shut-off valves for maintenance of automatic devices.
    B. Extend the vent or drain piping, if required, to allow installation of valves and assemblies at convenient service locations. Extend vent discharge piping to a safe location; extend drain discharge piping to a floor drain or other appropriate location such as the condensate return system for steam traps.
    C. Provide vacuum relief's at coils, heat exchangers, and other heat transfer devices as required.

18. HANGERS AND SUPPORTS
    A. Specify hangers and supports with special considerations for vertical piping and connections to equipment. Use vibration eliminating hangers for piping near pumps, fan coil units, and other dynamic equipment for vibration-sensitive applications.
    B. Provide seismic restraints to meet local codes. Use SMACNA Guide restraints where applicable. Attachments to the building structure must be adequate and shall be detailed and/or specified.
    C. Pipe, valves, and accessories "in-board" of flexible connections at vibration isolated equipment must be supported from the equipment inertia base or otherwise isolated with the equipment without putting undesirable stress on the equipment.

19. SECTION VALVES
    A. In addition to local connections to equipment, provide piping systems with isolating valves to facilitate maintenance and minimize the extent of the system that must be shut down for repairs, modifications, or expansion. In general, provide an isolation valve, ball, gate or butterfly, at all pipe header connections to eliminate total system drainage during future piping modifications.
    B. The valve pressure rating must be a minimum of 1.5 times the working pressure of the system served.

20. MATERIALS
    A. Pipe valve fittings and accessories shall be of good quality. To ensure quality, specify piping by ASTM, AWWA, or other appropriate standard; specify ASME ratings for valves and list brand names as a standard; specify fittings by ANSI or another appropriate standard.
    B. All materials must meet applicable codes. Where standards may not be sufficient to ensure the quality desired, specify a brand name as a means of establishing the quality level. Whatever method is used, be specific. Include pipe joint materials and methods in the specifications.

21. CLEANING AND TESTING
    A. After installation, all systems shall be properly cleaned by flushing with an appropriate liquid or gas before installation of valves and final connections to the equipment. After flushing, closed heated and cooled water systems shall be cleaned by circulating a solution of trisodium phosphate or a similar agent before the final flush and fill. Untreated water and all cleaning and water treatment chemicals shall be approved by EHS by going through the OSU Project Manager.
    B. Isolate the cooling tower from all piping flushing and cleaning operations to prevent untreated water from entering the basin.
    C. Before their final acceptance all strainers, drip legs, and similar items shall be thoroughly cleaned.
    D. All tests must be observed by OSU's Project Manager. In general, test systems at 1-1/2 times the highest system operating pressure for 24 hours.
    E. Any tank for chemicals which may enter the sewage system will be located so it can be easily charged and serviced.

22. DIRECT BURIED PIPING
    A. Minimum burying depth for all direct buried piping is 36 inches.
    B. Do not run within the drip line of existing trees.

23. DUCTWORK
    A. Refer to Section 23150

Section 23 30 01 – Air Side Systems

PART 1 - GENERAL

1. DUCT DESIGN
   - A. Duct Sizing Criteria
     - 01. Air Systems
       - a. Volume dampers shall be provided in all supply air branch ducts and at all supply air outlets. Volume dampers shall not be placed upstream of VAV terminal units. Supply air duct systems shall be designed with care and considerations to minimize the overall system pressure drop.
       - b. Low Pressure Supply Return or General Exhaust
         - (1) Maximum pressure drop: 0.10 inches w.c. per 100 ft.
         - (2) Maximum velocity:
           - a) Supply Diffuser run out: 500 fpm.
           - b) Return or exhaust grille run out: 600 fpm.
           - c) Branch duct above ceiling: 1750 fpm.
           - d) Mains in mechanical rooms or shafts: 2,000 fpm.
           - e) Exposed mains: 1,450 fpm.
       - c. Medium Pressure Supply
         - (1) Maximum pressure drop: 0.35 inches w.c. per 100 ft.
         - (2) Maximum velocity:
           - a) Branch to terminal unit: 2,200 fpm.
           - b) Round branch above ceiling: 3,000 fpm.
           - c) Rectangular branch above ceiling: 1,750 fpm.
           - d) Round main in mechanical rooms or shafts (above 35,000 CFM): 3500 fpm.
           - e) Rectangular main in mechanical rooms or shafts: 2,500 fpm.
           - f) Exposed round mains: 2,600 fpm.
           - g) Exposed rectangular mains: 1,450 fpm.
   - B. Kitchen Exhaust
     - 01. Ductwork and exhaust systems (serving Type I or Type II kitchen hoods) shall be designed and constructed per NFPA requirements.
     - 02. Ductwork serving a Type I hood will be constructed from stainless steel, pitched back to the hood with condensate drains, fire sprinklers, access doors at changes in direction, and separate from any other exhaust systems.
     - 03. Dishwasher exhaust will be constructed from aluminum or stainless steel.
     - 04. Hood exhaust fans shall be approved specifically for this application and shall meet the requirements of the local authorities having jurisdiction and NFPA.

05. Locate supply and exhaust grills away from exhaust hoods to prevent air being discharged from effecting hood performance.
06. Provide makeup air systems, per State Energy Code.
07. Minimum velocity for duct design: 1,500 fpm.
08. Maximum velocity for duct desgin: 2,500 fpm.

C. Lab Exhaust Duct Design
01. Ductwork for lab exhaust systems shall be constructed from stainless steel duct, pitched back to the hood and be separate from any other exhaust systems.
02. VAV lab exhaust systems using Phoenix Controls are preferred for new construction where there are mupltiple exhaust hood in a building. See #9 Variable Air Volume (VAV) Systems.
03. Locate supply and exhaust grilles away from exhaust hoods to prevent air being discharged from effecting hood performance.
04. Hood stacks will be a minimum of sixteen feet above the standing surface at the point where service personnel will stand to work on the equipment or perform other tasks.
05. Stacks located on sections of buildings within fifty feet of taller section of the building will be constructed as if they were on the taller section (ie., sixteen feet above the standing surface of the taller section).
06. Other physical arrangements may be suitable with equipment that is designed for outside dilution air, high discharge velocities, and higher effective stack height. Such systems will be reviewed and approved on a case-by-case basis by EH & S. In no case will physical stacks terminate LESS than 6.5 feet above the standing surface.
07. Maximum pressure drop: 0.35 inches w.c. per 100 ft.
08. Reciruclation of any laboratory hood exhaust is prohibited.

D. Maximum velocity
01. Mains 2500 fpm
02. Branches 1500 fpm
03. Minimum stack exit velocity 3,000 fpm

2. ROTATING EQUIPMENT
A. Do not locate rotating equipment above hard ceilings

3. DUCT SEALING
A. Seal all low and medium pressure metal supply exhaust and return ductwork, per SMACNA Class A standards using either adhesive, gaskets, or tape systems.

4. DUCT PRESSURE TESTING
A. Test all ductwork slated to operate at ≥ 4 inches water gauge.

B. Randomly test three sections of medium and three sections of low pressure ductwork slated to operate at ≤ 4 inches water gauge.

5. DUCTWORK CONFIGURATION
   A. Utilize spiral round duct wherever possible for low velocity.
   B. Utilize rectangular where round duct will not fit.
   C. For medium velocity, mains and branches utilize flat oval ducts where round ducts will not fit.
   D. Utilize rectangular ductwork where flat oval sizes are not available for supply ducts.
   E. For return and exhaust ducts utilize round where possible and rectangular otherwise.

6. ZONING
   A. Provide exterior zones around the perimeter of the building and interior zones for the remainder of the area.
   B. Perimeter zones to be a maximum of 15 foot deep.
   C. Corner rooms having two different exposures shall be made a separate zone if practical.
   D. Meeting and conference rooms shall be made separate zones.
   E. Other specific zoning requirements will be provided by the PM.
   F. Terminal Unit Area of Coverage:
      01. Maximum exterior zone size: 1,000 sq.ft.
      02. Maximum interior zone size: 1,800 sq.ft.

7. DUCT LAYOUT
   B. Indicate the desired layout on the Construction Drawings using double lines to delineate ducts to scale; use standard symbols.
      01. Show items such as dampers, lining, turning vanes, extractors, splitters, air flow measuring stations, and other features required for good control of air.
      02. Indicate round ductwork where possible.
      03. If rectangular ductwork is used, specify radius turns where possible.
   C. Keep the duct aspect ratio at 3 to 1 or less where possible, but not over 5 to 1 unless approved by the OSU Project Manager. Arrange the layout to avoid items that pass through ductwork unless absolutely necessary. When penetrations occur, specify an airfoil section around them.
   D. Coordinate the location of ducts with other building features such as columns, ceilings, conduit, piping and lighting fixtures. Position ductwork to allow for the removal of, or access to, filters, terminal box coils or controls, lighting fixtures, fire dampers and other similar items.

E. Ductwork design: To design the system, consider noise, pressure drop, the type of system, the type of duct material, vibration, drumming, fire and smoke control, and any other factors that may affect sizing.

F. Hangers and supports

01. The type and size of hangers and support shall follow ASHRAE and/or SMACNA recommendations. Seismic restraints where applicable shall be designed, specified and detailed as recommended in SMACNA's "Guidelines for Seismic Restraints in Mechanical Systems". Spring or other resilient supports shall be used in hangers where sensitivity to vibration is a problem. Coordinate with the other design disciplines when specifying or designing the duct support and hanger locations.

G. Dampers

01. Manual and automatic opposed blade volume control dampers, back draft dampers, inlet vanes, and fire and smoke dampers shall be shown in duct layouts where required. Provide adequate room around shafts for fire/smoke damper sleeves.
02. Where possible, select 100 percent free area fire and smoke dampers that have their entire assemblies approved by the Underwriters' Laboratories and any governmental agencies having jurisdiction.
03. After completion of the duct layout, review the design for proper arrangement and for adequacy of the volume dampers to ensure ease of initial balancing and of rebalancing to accommodate future modifications.

H. Cleaning

01. Specify that duct systems are to be wiped down, vacuumed, or blown clean with compressed air before installation, and that all ductwork is sealed with plastic after cleaning and during assembly to keep ducts clean. All ductwork shall be shipped sealed to the job site and kept sealed until construction is complete. Store ductwork out of the weather at all times.
02. The return duct system shall be kept sealed at all times during construction to keep it clean. If heat is required in the building prior to finish of construction 100% outside air shall be used.
03. Require the contractor to provide and install a new, complete set of clean filters shortly before final acceptance.
04. Fans shall be operated with construction filters installed, at full air volume for 24 to 48 hours after installation.

I. Special requirements

01. Supply and return ductwork

a. Use galvanized sheet metal spiral round, rectangular, and flat oval ductwork, in that order, unless special conditions dictate use of other materials. Use pressure and/or velocity criteria to select gauge thickness according to the ASHRAE Guide or SMACNA.

02. Exhaust ductwork
    a. Ducts must convey ambient temperature or heating exhaust, smoke and grease from kitchen hoods, moisture, abrasives, and other exhaust air streams that are not acids or caustics. Use the following materials for these exhausts:
    b. Specify the gauge for galvanized sheet metal as recommended in the ASHRAE Guide or SMACNA. Ductwork for kitchen exhausts and abrasives shall have material thickness as recommended in the references.
    c. Kitchen Cooking Hoods: Welded steel (conform to NFPA).
    d. Dish Washing Exhaust: Use 304 stainless steel material for moisture latent air streams. Pitch ductwork to dish washing hood or to duct mounted drains.
03. See Section 11050 for fume exhauset ductwork requirements

8. LABELING
   A. All accessible ductwork shall be color coded and identified with wording and arrows every 20 feet on straight runs, at each riser, at each junction, at each access door, adjacent to all valves and, flanges, on both sides of floor and wall penetrations and where required to easily identify the medium transported.
   B. smoke dampers shall be permanently identified on the exterior by a label with letters ½ inch in height reading: Fire Damper, Smoke Damper, or Fire/Smoke Damper, as appropriate. The label will be constructed from same material as equipment nameplates.
   C. Terminal Units: Mark all terminal units with a grease pencil so that the markings can be easily read from the most likely viewing position (i.e., catwalk, through the ceiling below, etc.).

9. VARIABLE AIR VOLUME (VAV) SYSTEMS
   A. VAV systems shall be used for administration and general office areas including lobbies, cafeterias, and meeting rooms, unless otherwise approved by the Project Review team and directed by the PM.
      01. VAV air handling systems must be capable of stable operation over a wide air quantity range. The selection and arrangement of terminal units shall minimize modification required to accommodate changing tenant configurations.
      02. Terminal units shall also be capable of stable operation over a wide control range.
      03. VAV terminal units serving perimeter zones shall be provided with hot water heating coils.
      04. Supply and return fans serving VAV systems shall be provided with a variable frequency drive to varying the air volume in response to system pressure.

05. VAV terminal units may be allowed to go to shut-off where applicable or go to a minimum setting. Zone controls shall be designed to maintain required minimum ventilation rates.
06. VAV re-heat terminal units shall close to 40% or greater as required for ventilation prior to re-heat.
07. Recirculation of any laboratory exhaust is prohibited when using a VAV system for lab hood exhaust.

B. Recirculated air systems equipped with an economizer cycle shall be capable of supplying 0-100% outside air.
C. Air economizer systems shall be used whenever practical. Provide both dry bulb and enthalpy controlled economizers.
D. For conditions under which economizer systems are not required and shall not be used, reference ASHRAE/IES Standards 90.1-1989.
E. Constant volume systems shall be used for areas requiring constant air flow and areas with constant exhaust requirements.
F. Insulation – refer to Section 23155 – Ductwork Insulation

Section 23 30 02 – AIR SIDE EQUIPMENT

PART 1 – GENERAL

This section's purpose is to establish standards of quality and utility for the mechanical components. The engineer's task is to utilize equipment that provides the best value while conforming to these standards.

1. AIR HANDLING UNITS
   - A. Consider both blow-through and draw-through types of air handling units.Use extreme care in the design of draw-through type air handlers utilizing economizers to assure adequate air mixing prior to the coils and the control sensors.
   - B. Use variable speed/frequency drives as the means of providing air handling equipment volume control.
   - C. Basic equipment requirements
     - 01. Specify units complete with fan section, coil section and mixing filter box section. Sections shall be combined as required and mounted on a structural steel base, complete with accessories.
     - 02. In addition to any internal drain collection features all chilled and hot water HVAC systems will be provided backup leakage prevention measures that will contain any water condensation or leakage from the HVAC coil and prevent system condensation or leakage from migration to lower levels.
     - 03. HVAC unit housings are not permitted to be installed directly to slab or other flooring without a drain pan or waterproof membrane protective shield to collect condensation or leakage and prevent migration
     - 04. Metal drain pans or berms with durable waterproof membranes will be provided under each AHU housings or coil to collect leakage when the coil or end turns are perforated
     - 05. Metal drain pans or berms will be alarmed to indicate leakage unless safe drainage is also provided.
     - 06. Access doors shall be provided for all fan, coil, filter, and mixing box sections. Doors shall be gasketed to ensure air and water tightness with viewing window in fan section.
     - 07. Provide perforated metal liner over insulation on the inside of the cabinet.
     - 08. Provide internal lighting in each section wired to a common switch.
     - 09. Roof-mounted units shall be complete with factory fabricated roof curbs shipped knocked down for bolted assembly at the site. All curbs shall have seismic bracing complying with local seismic codes. The air handler subbase shall be full bearing on, and self- flashing to the curb. The curb substructure shall be constructed to provide a level surface for mounting

the curb. All coil piping, condensate drains, and electrical conduit shall be routed inside the unit casing and within the perimeter of the roof curb with no exposed piping on the roof.

10. See the Controls section of this document for control requirements. Factory mounted controls on package units are not acceptable.

2. FANS
   - A. Select most efficient type of wheel and analyze the sound power levels in each octave band.
   - B. Special fans include fiberglass-reinforced, plastic, stainless steel, and other special metals for acid, caustic, and other corrosive exhausts. Avoid coatings when possible. Use non-sparking aluminum wheels or all-aluminum fans for kitchen hoods and solvent fume exhausts.
   - C. Use variable speed/frequency drives for capacity control.
   - D. Basic equipment requirements
     - 01. Centrifugal Fans
       - a. Fans shall have all-steel housing, Class I or II construction. After assembly, fans shall be statically and dynamically balanced at operating speed.
       - b. Fans shall be tested in accordance with AMCA Standard 21067 and shall have evidence of this certification permanently affixed to units.
       - c. Fans of manufacturer's standard construction shall be finished with primer and enamel finish in manufacturer's standard color.
       - d. Single inlet fan housings shall be specified with a 1/2" diameter threaded drain fitting at the low point of the fan scroll.

3. FILTERS: THE FOLLOWING FILTERS AND ACCESSORIES SHOULD BE SPECIFIED AND SHALL MEET THE FOLLOWING MINIMUM CRITERIA:
   - A. Air handling units shall be equipped with both pre and final filters.
   - B. Pre-filter (panel type)
     - 01. The pre-filter shall be listed as Class 2 by the Underwriters' Laboratories.
     - 02. Filters shall have an average efficiency rating of 25-30 percent (MERV 6-7) by the ASHRAE Standard 52-76 test method using atmospheric dust.
   - C. Final-filter (extended media type)
     - 01. Specify replaceable, factory-assembled filter elements of fine-fibered, all-glass media.
     - 02. The replaceable media filters shall be held by a permanent gasketed holding frame with retaining clips to maintain a positive pressure seal between the frame and the replaceable filter element.
     - 03. The average efficiency of the filter shall be either 60-65% (MERV 13), 80-85% (MERV 14) or 90-95% (MERV 15) efficiencies, depending on area of service.

04. Filters shall be Underwriter's Laboratories listed (Class I or Class II, according to system requirements).

D. Air filter gauge
   01. Provide a gauge across each filter bank.

E. Discuss the level of filtration required with the OSU Project Manager.

4. SOUND ATTENUATORS

A. General
   01. When sound attenuators are used, specify the maximum acceptable calculated sound levels for particular locations. Rectangular low pressure drop units are preferable. Use medium or high pressure drop units or round units only when the others cannot be applied.
   02. Select units with a dynamic insertion loss at least 3 dB less from generated noise level in all eight octave bands.

B. Basic equipment requirements
   01. Outer casings shall be in accordance with ASHRAE Guide recommendations for high pressure ductwork. Casings shall not vibrate audibly during normal operation of the air handling system.
   02. The acoustically absorptive filler material shall be made from an inorganic fiberglass-like material. The material shall be inert, vermin-and moisture-proof, and impart no odor to the air.
   03. The filler material shall be incombustible and shall not exhibit more than the following fire hazard classification values when tested in accordance with standard ASTM E84, NFPA 255, or UL 723 test methods:
      a. Flame spread: 25.
      b. Fuel contributed: 20.
      c. Smoke developed: 0.
   04. Acoustical ratings shall be determined by the "duct-to-reverberation room" method in accordance with ASTM Specification E477. Airflow and pressure loss data taken in accordance with AMCA procedures shall be obtained from the same silencer used for acoustic performance tests.
   05. Calculate pressure losses carefully, particularly the inlet and exit losses.
   06. Coordinate the installation location of attenuators with the manufacturer-recommended installation guidelines.

2. COILS

A. General
   01. Heating and cooling coils shall be aluminum-finned copper tube with fin spacing no tighter than 10 fins per inch. Coils may be used for cooling, dehumidifying, and heating air and should meet the requirements of the Air Conditioning and Refrigeration Institute (ARI). Coil capacity ratings shall be certified in accordance with ARI Standard 410-72.
   02. Specify coils with vents and drains.

B. Basic equipment requirements
   01. Coils shall be drainable.
   02. Coil tubes shall be seamless copper. Avoid the use of turbulators.
   03. Coil fins shall be aluminum surfaced continuously across the entire coil width with full fin collars for maximum fin tube contact. Fins shall be mechanically bonded to tubes.
   04. Size dehumidifying coils so maximum face velocity will not exceed 500 FPM to prevent moisture carryover.
   05. All chilled water coils will be provided duct drip pans internal to the ducting to collect and drain condensation.
   06. In addition to any internal drain collection features all chilled and hot water HVAC systems will be provided backup leakage prevention measures that will contain any water condensation or leakage from the HVAC coil and prevent system condensation or leakage from migration to lower levels.

3. DIFFUSERS, REGISTERS, AND GRILLES
   A. Select all air outlets with consideration for air throw pattern, drafts, noise and compatibility with architectural requirements. Call for factory applied baked enamel or other suitable finish and coordinate the color with the architect.
   B. Unit sizing is based on air being introduced at 20 deg. F. temperature differential and being diffused at the 5 ft. level to a velocity not greater than 50 FPM and a temperature differential not greater than 1.5 deg. F.
   C. Units selected will not exceed design sound level for the space served.

4. TERMINAL UNITS
   A. Units shall be pressure independent and electrically or pneumatically actuated. Specify clearance for access and removal of components.
   B. Specified variable volume terminal units shall meet the following minimum criteria:
      01. Terminals shall be pressure independent and capable of resetting the air flow between a preset maximum and minimum as determined by the space thermostat, regardless of changes in system air pressure. The terminal air valve shall return to the minimum air flow setting on loss of the control signal, unless otherwise specified.
      02. Each variable volume terminal shall be factory set for the maximum and minimum level air quantity shown in the terminal schedule.
      03. The casing shall be constructed of coated steel meeting SMACNA or ASHRAE Standards. Internal insulation shall meet the requirements of NFPA Bulletin 90-A and UL 181.
      04. Terminals shall be complete with factory furnished and installed actuators and accessory controls.

05. ll terminal hot water heating coils shall be furnished by the terminal manufacturer and shall be internally mounted in the casing at the factory. Coils shall be of the slip-in type, removable from the side. The design shall provide even air distribution across the coil face to ensure optimum coil performance. Use electric reheat coils only with permission of the Project Review Team.
06. Terminal units must be capable of stable control over a wide turn-down ratio. Terminal units shall be sized and arranged to facilitate the relocation of process cooling loads with minimum disruption to the HVAC system.
07. Provide 5-feet of lined sheet metal discharge ductwork for units below 1,500 cfm, and 10-feet long for larger units prior to the first duct takeoff. Provide Mylar facing over insulation to allow for cleaning.

C. The quality of items not covered in these standards shall be of the same general level and be subject to the same tests of value as those that are included.
D. Select items made by established manufacturers who have demonstrated the capability to provide replacement parts and service as may be required. The quality of the manufacturer's local representation is very important.
E. Analyze manufacturers' designs for inherent maintenance qualities, as well as adequate access doors, fasteners, and other accessories, which will facilitate maintenance.

Section 23 66 00 – GENERAL

1. REFRIGERANT CONTAINING EQUIPMENT (RCE)
   A. This section applies to the management of refrigerant containing equipment during new construction, demolition, renovation, or preventative maintenance activities.
   B. Whenever possible, attempt to utilize equipment that contains Hydrofluorocarbon (HFC) type refrigerants (non-ozone depleting type refrigerants). Equipment that utilizes either Class I or Class II refrigerants should be avoided when feasible.
      01. Class I refrigerants include the (CFCs), R-11, R12, R13, R-13B1, R113, R114, R115, R-500, R502 or R503.
      02. Class II refrigerants include the Hydrochlorofluorocarbons (HCFCs), R-21, R-22, R-23, R-31, R-121, R-122, R-123, R-124, R-141b, R-142b, R-401a, R-401b, R-401c, R-402a, R-402b, R-403b, R-406a, R-408a, R-409a, R-411a, R-414a, R-414b, FRIGC FR-12, Free Zone, GHG-HP, Freeze 12, GHG-X5, G2018C, or NARM-502.
   C. When refrigerant containing equipment is removed, dispose of equipment and refrigerants properly.

Section 25 30 00 – INTEGRATED AUTOMATION INSTRUMENTATION & TERMINAL DEVICES

PART 1 – GENERAL

1. REQUIREMENTS
   - A. DESIGN
     - 01. Throughout this design guide, manufacturers/installers are referred to as the contractor.
     - 02. Currently approved manufacturers/installers:
       - a. Siemens Building Technologies Inc.
       - b. Johnson Controls Inc.
       - c. Alerton
       - d. Other manufacturers may be approved if they can demonstrate interoperability by manipulating and controlling the other vendor's devices. The demonstration must occur prior to the of the schematic design portion of the project.
     - 03. The Energy Management System (EMS) shall be a distributed intelligent network (DDC) that is fully compatible with the Johnson Controls Metasys System or the Siemens Apogee System or the Alerton BACnet system currently installed on the Oregon State Campus. Full compatibility is defined as a seamless ability to take full advantage of all network and DDC operating capabilities of the existing campus-wide EMS.
     - 04. BACnet device instances shall be coordinated between all systems using BACnet protocol through OSU's Facilities Services IT staff.
     - 05. Installation of the Siemens and Johnson systems is to be performed by the branch office. Installation by the Alerton system is to be performed by Environmental Controls Corporation.

2. CENTRAL EQUIPMENT AND OPERATING SYSTEM
   - A. Each of the existing approved control systems has a central monitoring and control station located in the EMS Shop. These are the primary computers for each of the different control systems on campus. Each system is configured to perform all the data gathering and processing functions, communication with peripherals, and application packages. The control program provides for all operational needs, without requiring any program changes.
   - B. Provide a new local workstation in each new building with additional licensing as required by the system. Workstation to be capable of monitoring and manipulating all of the controls in the building and be able to access the systems in other buildings. This workstation does not take the place of the primary workstation in the EMS Shop.
   - C. Portable Workstation
     - 01. Verify with the OSU Project Manager and EMS Shop if a portable workstation is required.

02. The portable operator's workstation shall include all of the functions, capability, and software tools of the main workstation located in the EMS Shop.
03. The portable operator's workstation shall be a light weight laptop from a main stream supplier like Dell or Toshiba and be capable of operating third party software.
04. As part of the portable workstation package, provide all necessary field tools, testing cables and equipment necessary to work on the control devices in the field.

D. Consultant to specify that the local building computer workstation is to be provided to OSU prior to installation. OSU will load the Windows Operating System and OSU Network and security drivers. The computer will then be returned to the contractor for installation of control software.

3. ENERGY MANAGEMENT SYSTEM

A. The energy management system shall operate under the control of one or more microprocessors/microcomputers with peripheral hardware and software configured to perform the following functions.
01. The system shall be a fully modular family of programs, peripherals, and application packages designed specifically for building management, including energy management, HVAC control and monitoring, and controlled access.
02. The system shall be capable of interfacing with the existing installed primary computer system located in the EMS Shop and shall allow for future expansion of both input/output points and processing/control functions and operating stations
a. Specifically, it shall be easy to add components, including memory, peripherals, field devices, and software, to the system to expand the size of the scope of automation.
03. Provide a minimum of 10% spare point capacity at each stand-alone cabinet.

B. All materials and equipment used shall be standard components, regularly manufactured for this system and shall not be custom designed especially for this project. All systems and components shall have been thoroughly tested and proven in actual use.

C. The EMS shall include full support for its compatibility with the system. In addition, the EMS shall use the latest product line offered by the EMS manufacturer.

4. REMOTE INPUT/OUTPUT DEVICES

A. Sensors installed as part of this system shall meet the following minimum accuracy requirements:
01. Temperature

a. Space: 0.75F accuracy.
b. Outside air: 1.0F accuracy.
c. Chilled Water: 0.75F accuracy.
d. Heating Water: 2F accuracy.

02. Relative humidity: 5% of full scale accuracy.
03. kWh and kW demand: range suitable for site, 1% of full scale accuracy.
04. Pressure: range suitable for application, 2% of full scale accuracy.
05. Pressure switches: adjustable settings, 2% of full scale accuracy.
06. Sensors located outdoors shall have suitable weather shields to provide protection from wind, rain, solar effects and radiation from nearby buildings.
07. Water temperature sensors shall be immersion-type. All transducers shall be industrial-grade quality.
08. All equipment will be provided with manual overrides (H.O.A. Switches) and shall remain able to be manually overridden (Hand or Off position), but shall be set in the automatic position. Provide HOA in control panel at EACH air handling unit, exhaust fan, or pump start/stop function except where an MCC HOA is provided.

5. SOFTWARE: GENERAL

A. The system shall be a user-programmable direct digital control system, utilizing P.I.D. (proportional-integral-derivative) algorithms for the control of all modulating equipment.

B. The system shall support multiple users performing multiple tasks. System changes (add points, modify programs, ect.) shall be able to be performed while the system is on-line. Alarms shall be able to be printed while system changes are being made.

C. The software shall include diagnostics to isolate component failures and verify system operation.

D. If the most current version of the system's graphic workstation software and programming tools already exists on the primary EMS Shop computer, the contractor is to be responsible for updating the graphic and software packages for incorporation of the new building's controls on the primary computer in the EMS Shop and all related workstations.

E. If the workstation software and programming tools are not the latest versions on the primary EMS Shop computer, the contractor is responsible for updating the primary EMS Shop computer software and programming tools to the latest version and the incorporation of the new building's controls. In addition, each remote building computer on the contractor's network is to be updated to show the new building's control screen.

6. OPERATOR COMMUNICATION AND ACCESS
   A. Graphical Software: Provide personal computer-based software that is compatible with a computer-vendor-supplied and supported, unmodified real-time disk operating system such as MS-DOS.
   B. The software shall provide, as a minimum, the flowing functionality:
      01. Graphical viewing and control of environment.
      02. Scheduling and override of building operations.
      03. Collection and analysis of historical data.
      04. Definition and construction of dynamic color graphics.
      05. Editing, programming, storage and downloading of controller database.
   C. Software for the workstations shall provide for a windowed approach
   D. Provide functionality to allow for any analog point value to be displayed as an individual dynamic display window for use as a convenient control and diagnostic tool. The display window shall include the following information as a minimum:
      01. Point name.
      02. Point description.
      03. Set point.
      04. Current value.
      05. Range of values.
      06. High and low limit set points.
   E. All values shall be displayed in both text and symbolic form, such as an analog bar, gauge or other standard measurement device.
   F. Provide the capability to control any point from a dynamic graphic display.
   G. Provide a graphical spreadsheet-type format for simplification of time-of-day scheduling and overrides of building operations. Provide the following spreadsheet graphic types as a minimum:
      01. Weekly schedules shall be provided for each building zone or piece of equipment with a specific occupancy schedule.
      02. Zone schedules shall be provided for each building zone as previously described.
      03. Monthly calendars for a 24-month period shall be provided to allow for simplified scheduling of holidays and special days in advance. Holidays and special days shall be user-selected with the pointing device and shall automatically reschedule equipment operation as previously defined on the weekly schedules.
   H. Provide trending capabilities that allow the user to easily monitor and preserve records of system activity over an extended period of time. Any system point may be trended automatically at time-based intervals or changes of value, both of which shall be user-definable. Trend data may be stored on hard disk for future diagnostics and reporting.
      01. Trend data report graphics shall be provided to allow the user to view all trend point data.

a. Provide additional functionality to allow any trended data to be transferred easily to an off-the-shelf spreadsheet package such as Microsoft Excel.

02. A collection schedule function shall be provided to automatically collect trend data without impacting performance of the system.

03. Setup individual trending logs that record usage data every 15 minutes for the building electrical, steam, natural gas, condensate, domestic water, chilled and heating water flow, inlet and outlet temperatures and BTU. See Section 33050 for metering requirements.

04. Provide additional functionality that allows the user to view trended data on trend graph displays: Displays shall be actual plots of both static and real-time dynamic point data.

I. A full screen, forms based point editor and programming function shall allow for point additions, deletions, changes, program modification and creation and point and program storage. This program shall be similar to a word-processing format such that full documentation of program changes may be available. This program shall provide the user with the capability to insert full English narratives to describe the control program. Search, insert, find, cut and paste functions shall allow for quick program modifications.

J. Provide a general purpose graphics package which shall allow the user to quickly and easily define or construct color graphic displays.

K. Provide the capability to backup and store all system databases on the primary workstation hard disk. While the primary workstation is on-line without disrupting other system operations.

L. Provide context-sensitive help menus to provide instruction appropriate with the operation and applications currently being performed.

M. Multiple user security levels shall be provided to allow for various degrees of system access and control.

01. The workstation shall be provided with a keg element display that records log-ons, log-offs, TOD overrides, alarms and alarm acknowledgments.

02. Provide a 500 element circular buffer for recording purposes.

03. Key element reports may be filtered by operator name and may be run for a user-defined time interval.

7. SUMMARIES AND LOGS

A. The system shall be provided with a log function. This function shall provide the system operator with a means of requesting a single point, all points in a given system, or all points in the building.

B. The system shall have the capability of generating the following reports as a minimum:

01. Program Summary: Upon operator request, the system shall output a programmed start/stop, time summary. This summary shall contain all

points, their associated programmed start/stop times and the respective days of week.

02. Limit Summary: An Analog Limit and Differential Summary shall be provided that details the high and low limits and limit differentials for all analog points, or all analog points within a unique building system.
03. System Log: A System Log shall be provided which contains the point status of all points specified by operator input.
04. Trend Logs: Trend Logs shall provide a means of producing a hard copy printout of points selected by the operator on a periodic time basis to form a trend log. The operator shall have the ability to add or delete points and select the reporting time interval.
05. Alarm Summary: An Alarm Summary report shall be printed automatically each day. This shall contain all alarms for that day, any previous open alarms and acknowledgement of alarms.

8. ENERGY CONSERVATION APPLICATION PROGRAMS
   A. Scheduled Start/Stop: The scheduled start/stop program consists of starting and stopping equipment based on the time of day and day of week.
   B. Optimized Start/Stop: The scheduled start/stop program described is refined by automatically adjusting the equipment operating schedule in accordance with space temperature and outside air temperature. In the scheduled start/stop program, the HVAC system is restarted prior to occupancy to cool down or heat up the space on a fixed schedule independent of outside air and space conditions.
   C. Enthalpy Control: The enthalpy cycle uses outside air to reduce the building's cooling requirements when the enthalpy of the outside air is less than that of the return air.
   D. Chilled Water Reset: Based on system requirements, the chilled water temperature shall be reset upward until the space with the greater cooling requirement is JUST satisfied.
   E. Heating Water Reset: Based on system requirements, the heating water temperature shall be reset downward until the space with the greater heating requirement is JUST satisfied.
   F. Supply Air Reset: For HVAC systems in a cooling mode, this program shall reset the discharge temperature upward until the space with the greater cooling requirement is JUST satisfied.
      01. When humidity control is required, the program shall prevent the cooling coil discharge temperature from being set upward when the maximum allowable humidity is reached.
      02. On applicable air handling units, supply air temperatures shall be reset as appropriate during morning startup to minimize heat-up or cool-down periods prior to scheduled occupancy.
   G. If night purge is part of the design, a night purge cycle is required.

H. A building warm-up cycle using 100% return air is required.

I. Use a state of the art variable air volume system with direct digital control at each terminal unit.

J. Each enclosed space designed for continuous occupancy (ie. classroom, lab, etc.) will be served by at least one separate VAV device, and will have its own temperature sensor.

9. MONITORING AND ALARMS

A. The system shall automatically and continuously monitor and record the values of all inputs points, and the status of all controlled equipment. In the event of the following conditions, an alarm message is to be generated and displayed at the operator's terminal and an audible alarm started.

01. If a binary output point changes state without a command.
02. High and low alarm for analog points.
03. Field device failure, as sensed by a binary input point.
04. Manual override of controlled equipment.

B. The alarm display shall include a description of the alarm condition and its source. An alarm condition shall be displayed until the operator acknowledges it. The operator ID shall be recorded of an operator who acknowledges the alarm.

10. WIRING

A. All equipment shall be installed by skilled electricians and mechanics, who are properly trained and qualified for this work, and who shall be in accordance with governing codes.

01. All wiring between the automation system and sensors and control devices including any power wiring of devices and necessary conduit shall be provided.
02. Labeling: All wiring and tubing shall be labeled end to end with point address and point descriptor using mechanically printed permanent label.
    a. Label all pull boxes and junction boxes with permanent marker
    b. Plenum cable to be color coded for easy identification
03. Transient protection of system power supplies, data communication lines, digital hardware and controllers shall be provided. This protection shall consist of surge arresters which shall provide a low impedance ground path for surge voltages and lightning.
04. Equipment shall have a power ground.
05. Communications and instrumentation systems shall have a separate single point ground in addition to the power ground.
06. Communication and data lines shall have electrical shielding.
07. Run all control wiring as follows:
    a. Mechanical Rooms: In conduit
    b. Exposed in building spaces: In conduit
    c. Concealed in building walls and hard ceilings: In conduit

d. Concealed in t-bar ceilings: Plenum rated cable supported every 5 feet with j-hooks.

08. Run all wiring and conduit parallel to building lines.

09. Terminate all conduit with end protectors.

10. Provide strain reliefs where plenum cable enters junction boxes, pull boxes, and cabinets.

11. SUPERVISION AND CHECKOUT:

A. This process shall be conducted by factory-training engineers and technicians directly employed by the contractor.

B. OSU will review of the controls shop drawings concurrently with the engineers review.

12. ACCEPTANCE TESTING

A. An acceptance test in the presence of the commissioning agent and or the engineer shall be performed. This test shall include, but not be limited to:

01. Complete verification of transmission media operation.

02. Cross-check of each sensor and control point.

03. Final calibration of the sensor.

04. Verification of failure mode operation.

05. Verification of program loading/unloading capability.

06. When the system performance is deemed in accordance with these specifications, it shall be accepted and placed under warranty.

13. TRAINING

A. The contractor shall provide full instruction to the owner's designated representatives in these procedures during the start-up and test period. These instructions are to be conducted onsite in a hands on manner when the system is fully operational during normal working hours. Training on the functional operation of the system shall include:

01. Operation of equipment.

02. Programming.

03. Diagnostics, including the configuration and management of trends.

04. Failure recovery procedures.

05. Alarm formats.

06. Maintenance and calibration.

07. Trouble shooting, diagnostics, and repair instructions.

08. Trending logs – how to set up, how to use, how to delete.

B. Additional training shall be provided off campus at the manufacturer’s facility. The manufacturer is to include the cost of the training as part of their bid. OSU pays travel and per diem costs for their employees. The manufacturer will conduct a 1-week of certification course training for two students for a total of 80 hours.

14. INSTRUMENT AIR COMPRESSOR
    A. The duplex air compressor must be sized to operate no more than 33% of the time. The unit must be sized to operate at a low piston speed and low temperature to minimize oil vaporization and carryover. Provide an automatic lead/lag selection.
    B. The receiver must be ASME labeled with a pressure gauge, a relief valve, and an automatic drain. The size to require no more than 10 starts per hour of an individual compressor.
    C. Provide a refrigerated dryer to assure a 39 ° F dew point.
    D. Air piping;
        01. Exposed: hard drawn copper or single tube polyethylene in a protective raceway, or multi tube polyethylene with vinyl jacket.
        02. Concealed above ceiling: single tube polyethylene in a protective raceway, or multi tube polyethylene with vinyl jacket.
        03. Buried: hard or soft drawn copper tubing or polyethylene tubing in a metal conduit.

15. CONTROL POWER
    A. Provide a duplex outlet at each building's automation system panel.
    B. Each outlet must be on a dedicated circuit feed from the life safety power system.
    C. Feed all global controllers, critical air handling unit controllers, chillers and boiler controllers, from the Life Safety Power System.

16. FIRE ALARM INTERFACE
    A. When required, interface the building automation system to the fire alarm system.
    B. Interlock the fire smoke dampers to the fire alarm system such that scheduled fan shutdown does not trigger the fire alarm.
    C. On new building or major remodel projects the control contractor is to be contracted directly to the general contractor, not the mechanical sub-contractor.

Section 26 00 00 – ELECTRICAL

PART 1 – GENERAL

Information for Design of System: All design shall be maintenance based and shall be designed with attention to maintenance and repair, working elevations, working clearance, replacement costs, OSHA standards, state and local codes, and all manufacturers' installation requirements. All work, design, and installation shall be done by licensed & bonded contractors, designers, or engineers.

1. REQUIREMENTS
   - A. EQUIPMENT AND INSTALLATION GUIDELINES
     - 01. During the initial planning, consult with OSU Facilities Services, regarding the choice of primary service voltage to be used, its location, and the capacity available. An important aspect of power system design and installation involves consideration of service reliability of the proposed systems and loads that are to be supplied. System Installation inspection and service reliability will be performed by the Contractor in the presence of the University Representative(s), Facilities Operations , and the Electrical Shop when and if the systems are to be connected to University electrical power systems. The system shall not be energized if these requirements are not met or it fails final inspection.
     - 02. Contractor(s), Designers, and Engineer(s) are responsible for addressing all the design review comments to the satisfaction of the University in order to assure the continued reliability of the University power distribution system.
     - 03. Copies of all electrical permits and inspections, including final inspection, shall be given to project manager and the OSU electric shop within 10 days of receipt.
     - 04. No exceptions to Construction Standards without written approval from specific shop.
     - 05. All plans/drawings shall have the Construction Standards version listed in the lower right hand side of plan/drawing.
   - B. PERMITS
     - 01. Copies of all electrical permits shall be provided to Project Manager and the OSU Electric Shop within 10 days of receipt.
     - 02. Copies of all inspections, including final, shall be provided to Project Manager and the OSU Electric Shop within 10 days of inspection

C. SAFETY

01. The incorrect application of electricity and unsafe installation can cause both minor and serious accidents. The Designer must remain vigilant to electrical hazards and take appropriate steps in meeting all safety rules and regulations in electrical power and installation distribution design. It is important that the design meet requirements of all appropriate codes, standards and guidelines, including, but not limited to, the following codes and regulations: State and local, UL, NEC, NESC, NFPA, NEMA, NECA, ASHRAE, ISESNA, IEEE, ANSI, ADA, IBC, and OSHA. It is also important that all the equipment, devices and installations supplied and installed in all University's Facilities meet high level of safety requirements, and the OSU Construction Standards. It shall also be known that the equipment, devices, and installation that fail to meet these requirements will not be accepted.

D. SHORT CIRCUIT STUDY, ARC FLASH STUDY AND OVERCURRENT PROTECTION STUDY: For all new buildings transformers or new buildings with electrical services where electrical work is being performed a short circuit study, an arc flash study and an overcurrent protection (coordination) study shall be provided.

The start point of each study will be one overcurrent protective device "upstream" of the starting point of the scope of work of the project and terminating at the farthest point "downstream" affected by the "upstream" changes.

01. Each study shall include the elementary diagram of the circuit being analyzed.

02. The short circuit study shall depict the available fault currents at critical points in the distribution system. The study shall indicate the fault rating of the equipment being analyzed and designated with a "pass"/"fail" marking. Where available currents exceed the short circuit ratings of the equipment, the equipment shall be revised to a component with a higher short circuit withstand rating.

03. The arc flash study shall be performed in accordance with NEC, NFPA and OSHA safety standards. Available fault currents shall be shown on the elementary diagram at critical points in the distribution system. The PPE level shall be provided at all switchboards, panels, disconnect switches, starters and similar electrical components with proper labels provided. The University's goal is to have, and the consultant should strive to design, a system such that no more than PPE Class 1 is required for

maintenance of any electrical equipment with the exception that in main electrical rooms, PPE Class 2 is acceptable.

Categories of PPE as described in NFPA 70E are:

Category	Cal/cm^2	Clothing
0	1.2	Untreated Cotton
1	5	Flame retardant (FR) shirt and FR pants
2	8	Cotton underwear FR shirt and FR pants
3	25	Cotton underwear FR shirt, FR pants and FR coveralls
4	40	Cotton underwear FR shirt, FR pants and double layer switching coat and pants

Cal/cm2 are the units of incident energy that the PPE can withstand. Note that a hard hat with safety glasses/goggles/full-face shield (where applicable) and the appropriate gloves are required also.

04. The coordination study shall be provided to assure both overcurrent and short circuit selective coordination occur to provide an orderly shutdown and to minimize extent of outages.

05. These studies shall be part of the design services.

E. Equipment belonging to other University Departments shall not be installedFacilities mechanical or electrical rooms, unless permission is given by Facilities Operations in writing.

F. PROHIBITED MATERIALS AND CONSTRUTION PRACTICES:

01. Extra flexible non-labeled conduit or non UL listed conduit.

02. Plastic conduit for interior electrical use, except that PVC conduit may be used for power circuits below basement concrete floors in corrosive environments, and for ground wires in any location, or with approval from the University Facilities Electrical Shop. The transition from PVC to steel shall be made below the floor.

03. Aluminum wiring/bussing shall not be used.

a. Use of aluminum plated bus and aluminum wound transformers is prohibited.

04. Use of incompatible Materials: Aluminum fittings and boxes shall not be used with steel conduit. All materials in a raceway system shall be compatible.

05. Use of wire ties to support conduit.

06. Use of wood strips and wood screws to support lighting fixtures.
07. Direct burial electrical cable.
08. Electrical ducts crossing above gas piping.
09. Ducts within 10 feet of a buried steam line in any direction. If it becomes necessary to cross a steam line, acceptable insulation of the crossing must be approved by the OSU Electric Shop.
10. Hard insulated wire connectors, which have Bakelite, are prohibited.
11. Dimmable lighting unless permission is obtained in writing from the OSU Electrical Shop. See “Lighting Control” in this Division.
12. Armored or metallic BX cable. (AC, MC, or BX)
13. Non metallic sheathed cable.
14. Flat conductor cable type FCC, under carpet, etc.
15. Powder metal die cast connectors, fittings and couplings.
16. Locating the following equipment less than four feet from a wall: electrical equipment that permits or requires rear cooling, rear access for maintenance or cleaning, rear connection, and main distribution panels and equipment.
17. Bottom fed switches, breakers or fuses.
18. Switches in which the blades pivot on the top.
19. Switches, breakers, etc. that require greater than 75 pounds of force on the operating handle.
20. Irrigation controllers on shared circuits.
21. Use of cable tray with medium voltage conductors.
22. Use of busway other than as permitted in “Busways” of this Division.
23. Use of busway, for panel risers, without a means of disconnect.
24. Drilling, tapping of existing bussing in panelboards, switchboards and motor control center.
25. Troffers: Use of radiant ceiling panels.
26. Lamps not listed by an approved testing lab.
27. Lamps provided by only one manufacturer.
28. Fixtures that require proprietary lamps.
29. Inverter Ballasts. (See emergency/standby systems)
30. Entrance to an Electrical Closet from other than a hallway or exterior door, or mechanical room.
31. Electrical panels located in offices or classrooms.
32. Use of a bushing without a lock nut.
33. Use of communication cable tray to support power and lighting circuits/raceway.

34. More than two (2) offices on a single circuit. Multiple circuits are allowed for a single office as needed.
35. 15A wiring devices unless required by the NEC or specific equipment.
36. Use of gray wire on 208Y/120 volt systems. Use of white wire on 480Y/277 volt systems.
37. Metal conduit covers supported by a threaded body for outdoor use in corrosive environments.
38. Piercing type splices.
39. Without UL approval, the tapping of existing switchgear, switchboards, panelboards, and motor control centers to provide power for new feeders or equipment is prohibited in all University facilities.
40. Recessed luminaires that require ballast access through an opening.
41. Sharing motor circuits with power receptacles.
42. Installation of auditorium, atrium, stairwell or high bay lighting that requires construction of scaffolding for service and maintenance; or installations without also providing the proper means for service and maintenance of said lights. Project must have approval of the Facilities Electrical Shop for all high bay lighting.

ELECTRICAL MATERIALS AND METHODS

1. All materials shall be listed by an approved testing lab.

WIRE AND CABLE

1. MATERIAL:
   A. Copper conductors of 98 percent conductivity shall be used unless use is restricted by Government Agencies.

      01. All medium voltage distribution cables shall be UL listed, 1/c, copper, mil Ethylene propylene rubber (EPR) insulated, 15 Kv, 133% rated, shielded, MV 105 degrees C. Feeders shall consist of three (3) primary cables and one (1) 3/0 neutral. Extension or modification of existing 4100 volt or 20.8k volt cables can only be done with prior written approval of the University Electric Shop.

   B. Secondary Conductors:
      01. Color Coding
         a. Color coding for 480/277V and 208Y/120V shall be as follows:

Phase	**Voltage (208Y/120)**	**Voltage (480Y/277)**
Neutral	White*	Gray*
A	Black	Brown

B	Red	Orange
C	Blue	Yellow
Equipment Ground	Green	Green
Isolated Ground	Green with Yellow Stripe	Green with Yellow Stripe

*Each with identifiable color stripe

02. Solid and Stranded Wire:
    a. No. 14 AWG and smaller may be solid.
    b. No. 12 and larger shall be stranded.
03. Minimum Size for Lighting and Power Branch Circuits: No. 12 AWG.
    a. Use No. 14 AWG stranded for control wiring and auxiliary system circuits.
04. Field installed cords to portable equipment shall be Type ST or SO and field installed cords for normal equipment shall be Type SRDT or SPT-3 containing identified equipment.
05. Circuit wiring through ballast channels of fluorescent fixtures shall be 600-volt, 90 degrees C insulation. Fixture must be approved for through wiring, if this is used
06. General Use Insulation: NEC, 600-volt type THHN/THWN or XHHW.
07. Connections in No. 10 and smaller wire shall be made with threaded-on plastic or nylon insulated wire nuts. Crimp connectors, except butt connectors are prohibited. Joints in No. 8 and larger conductors shall be made with pre-insulated mechanical lugs.

WIRING DEVICES

1. DESIGN
    A. All wiring devices provided shall be 20A specification grade. New building devices will be ivory, white or brown with stainless steel plates for standard and ground fault interrupter use. Isolated ground devices shall be orange with stainless steel coverplates. Emergency/standby power devices will be red. Existing building designers shall match existing color scheme that is prevalent throughout building.
    B. Placement of receptaclesin University classrooms shall be coordinated with the current University Media department, for locations and minimums of new technology for learning.
        01. In standard size classrooms (49 students or less) provide a double duplex receptacle at the front of the classroom centered under the chalkboard or markerboard. Provide two additional receptacles at the front of the room spaced half way between corners and double duplex receptacles.

Back of the rooms to be provided with single duplex receptacle at the center of the wall. Remaining walls to be provided with two duplex receptacles on each wall equally spaced.

02. In classrooms with 50 students or more provide two duplex receptacles for the front wall, centered between the corners and one double duplex receptacle at the center of the wall. Provide two duplex receptacles equally spaced on all remaining walls.

03. Corridors shall be provided with duplex receptacles 35’ on center and a maximum of 10’ from end of corridor. These receptacles shall have separate circuits from the room circuits. In hallways and corridors adjacent receptacles shall be on alternate circuits.

04. Lecture halls shall be provided with a double duplex receptacle centered on front wall and two additional double duplex receptacles equally spaced between center double duplex and corners. Provide additional receptacles throughout for cleaning. These receptacles shall be a maximum of 25’ on center. If lecture hall is provided with a lab bench, then provide bench with one double duplex for every eight foot of bench.

05. Computer labs shall be provided with at least two general purpose receptacles equally spaced per wall in addition to all receptacles for computers.

06. Mechanical room shall be provided with at least four duplex receptacles (one per wall) and additional duplex receptacles where walls are 25’ or longer. At least one receptacle shall be fed from the emergency panel.

07. Projector and electronic display boards power, shall be surge protected.

C. Switches:

01. Switches provided for all uses shall be 20A specification grade. Color scheme shall match receptacles.

02. Switches provided at roof hatches or where provided outside of rooms they are serving shall be provided with pilot lights.

D. Cover Plates:

01. Generally coverplates for flush-mounted standard devices shall be stainless steel for interior use in new buildings. Where work is being performed in existing buildings, coverplates shall match the majority of the existing devices. In residential buildings covers shall be unbreakable nylon.

02. Coverplates for exterior use shall be a type which allows NEMA 3R rating to remain while in use. Where exterior device could be exposed to vandalism, provide locking type coverplates.

03. Shall be identified to source.

HANGERS AND SUPPORTS

1. REQUIREMENTS
   A. Materials for Straps and Hangers: Heavy-duty malleable iron or steel. For installation in locations above grade that are subject to moisture penetration, specify corrosion-resisting steel. Perforated straps are not acceptable.
   B. Independent Support Systems: Required for all installations.
      01. Surface outlet boxes, to which fixtures are attached, and pull boxes shall be fastened to the structure independent of the conduit system supports.
      02. Conduits above suspended ceiling shall not be supported by a ceiling suspension system.
   C. Coordination with General Construction: The Designer/Engineer shall include the following (or similar) statements in specifications for suspended lay-in ceilings:
      01. Surface mounted fluorescent lighting fixtures shall be supported from the structure above independent of any ceiling system by use of 3/8-inch all thread rods.
      02. Flush or recessed fixtures in ceilings of the suspended lay-in type shall be installed so that the long dimension of the fixture is supported on the main support member of the ceiling system. Provide at least two galvanized steel safety hanger wires or safety chains, attached from the fixture housing to the structure independent of the ceiling system. Wire or chain shall withstand a 3-foot, 50-pound drop test. In addition, the Luminaire Support Requirements of NEC shall be strictly followed. Manufacturer supplied grid clips must be utilized and installed per manufacturer instructions.
      03. Suspended ceilings in new construction shall have a minimum of 10 inches clearance below the lowest building structure, duct, and equipment.

RACEWAYS

1. REQUIREMENTS
   A. Interior Conduit and Fittings: Minimum conduit size for power circuits shall be 3/4-inch for home-runs. Minimum conduit sized for control wiring shall be ½-inch.
   B. Exterior Conduit and Fittings: Rigid galvanized threaded UL labeled conduit shall be specified where subjected to physical damage.

01. Threaded couplings shall be used with rigid conduit and IMC.
02. IMC may be used in place of rigid galvanized where permitted by code.

C. Steel Electric Metallic Tubing (EMT) UL labeled conduit may be used in interior partitions, above ceilings, and for surface application, except in corrosive and hazardous locations, where PVC coated rigid galvanized conduit is required to be used.
01. Insulating bushings and insulated throat fittings shall be used throughout EMT installation.
02. Compression fittings shall be used outdoors. Set screw type fittings may only be used indoors.

D. Plastic jacketed rigid galvanized steel conduit shall be used in corrosive atmosphere.

E. Flexible conduit used for motor make-up shall be liquid tight flexible conduit, minimum size ½ inch. Flexible conduit used for lighting fixture connections shall be steel, minimum size of ½-inch unless part of a manufactured assembly. Maximum length shall be 6'-0". Flexible conduit of any type shall not be used in interior partitions or in walls as a substitute for EMT, IMC or rigid steel conduit. A ground wire shall be pulled in all flexible conduits. All flexible conduits shall be supported. Distance between supports as allowed per NEC.
01. Liquid tight flexible metal conduit shall be used on flexible conduit applications exposed to outdoor or moist locations.
02. Liquid tight flexible metal conduit shall be used in raised floor computer room applications.

F. Rigid galvanized steel conduit shall be used outdoors, above grade, in damp locations.

G. Conduit installed through a building wall shall have internal and external seals. Specify link seal or equivalent.

H. Elbows used for medium voltage cable shall be long radius rigid steel.

I. Grounding: Conduit crossing building expansion joints shall have expansion provision with grounding continuity.

BUSWAYS

1. REQUIREMENTS

A. The Designer may use feeder Busways in lieu of conduit and wire where approved by the OSU, Facilities, Electrical Shop.

B. Plug-in bus shall be used in shops where the load density provides an economic advantage over panels and shall not extend into more than one space. Plug-in

bus shall be copper. Busway shall be used to serve one room or usable space. It is prohibited for busway to penetrate a fire rated wall.

C. Indoor busway (if used) shall be water resistant per current ANSI/IEEE Standards.

D. If use of busway is approved by special permission for a project, Contractor shall provide 10% of spare busway and 10% of total spare switches used. This includes when busway is installed in shop areas or specially approved conditions.

SURFACE RACEWAYS

1. REQUIREMENTS

A. Surface raceway shall not be used in new construction except as approved by the University Facilities Electrical Shop.

B. Surface metallic raceway with associated coupling, boxes and fitting shall be mounted to the surface of structure for the installation of electrical conductors when approved may be used in the following locations:

01. In dry locations.

02. In Class I, Division 2 Hazardous (classified) locations and as permitted by National Electric Code (NEC).

C. Surface non-metallic raceway shall not be used.

D. Fittings and Boxes:

01. Raceway shall have manufacturer's finish standard prime coating suitable for field painting.

02. The acceptable manufacturers for surface raceways shall include:

a. The Wiremold Co.

03. All junction boxes, pull boxes, conduit bodies…, above suspended ceilings, shall be accessible by step ladder or lift, without dismantling the ceiling.

UNDERGROUND RACEWAYS

1. REQUIREMENTS

A. All underground cables of any classification shall be installed in raceway systems. All the raceways for medium/high voltage shall be 6" in size and all others for street lighting and other applications shall be sized in accordance with the projected electrical load growth in the vicinity. Underground raceway systems for medium/high voltage systems shall be encased in concrete. Provide a yellow marker tape 18" above the conduits indicating "Danger Buried Conduits".

SECONDARY/LOW VOLTAGE ELECTRICAL DISTRIBUTION

1. REQUIREMENTS

A. Magnetic Interference and Mitigation

01. Magnetic interference can pose major problems in the design and operation of electrical and electronic equipment, instruments, control systems, data processing equipment and communication networks. This equipment frequently indicates aberrations whose sources may not be readily recognized, but which are due to magnetic interference. In general, such interference is classified as internal and external.
    a. Internal interference, created by operation of components within the system itself, can usually be eliminated or nullified by shielding the individual components and confirming the magnetic force they create.
    b. External interference is frequently caused by nearby or adjacent equipment such as transformers, medium voltage busway, or switching equipment, which generate magnetic “spikes” affecting apparatus which is not physically attached to the source of interference.
02. Special Protective and Preventive Materials: In addition to developing a basic protection design in preventing the penetration of magnetic interference, when it is required by this Standard to Design and specify EMF mitigation plans or strategies that will prevent and solve the magnetic interference problems as described in Section 26 10 00.1.a. The expectation of this standard is to reduce EMF to below one (1) milligauss, even in the most complex field environment.
03. Special EMF Shielding Material: There are two means of EMF shielding that may be used to achieve effective prevention of magnetic interference or eliminate the existing problems. See Sections 26 10 00.1.b and 26 10 00.1.d.
    a. In fields of low intensity, use CO-NETIC AA perfection sheet because of its high initial permeability and corresponding high attenuation characteristics. In fields with high intensity, use NETIC S3-6 sheet because of its high magnetic saturation characteristics. CO-NETIC AA Perfection Annealed Sheet are available in standard gauge .014” through .062” thick, in flat sheet sizes up to 30” x 59” or full sheet of .015” thick and 36” by 120”.
    b. Installation: For wall or floor coverings designer shall specify that sheets shall be butted at seams, all seams flush and tight.
    c. Fasteners: NETIC/CO-NETIC AA sheets shall be mounted to walls by non-magnetic fasteners to penetrate the shielding sheets. Hole in the NETIC/CONETIC AA alloy sheets for fasteners shall be

drilled with standard metal drills (cobalt steel drill bits). Special fastening application (masonry, concrete, etc.) shall be consistent with EMF shield manufacturer's recommended attachment procedures and EMU Building Design Standard requirements.

d. Seams: All seams between sheets to be covered by CO-NETIC AA foil, 0.01-inches thick, by 4-inches wide, with factory supplied PST backing. Apply foil centered over the sheet seams and press down tightly.

e. Finishing: The CO-NETIC AA metal has a natural shiny, silver colored finish and will not rust. Gypsum wall board (dry wall) or approved other materials shall be applied over the CO-NETIC AA sheets after seams are covered. No magnetic fasteners are to penetrate the CO-NETIC AA sheets.

f. Installation: All medium voltage transformers and switch gear including motor control centers that are adjacent to or under offices, computer enters/rooms or locations that will have the use of Sensitive Electronic Equipment (SEE) shall be shielded with ferro-magnetic material.

g. Use of minimum 10 gauge ferrous steel sheet metal on the side(s) of walls where said offices or rooms are situated, to prevent moving charges that produce Electric Magnetic Field (EMF) penetration that in turn destroys or distorts sensitive electronic equipment.

h. In order to have an effective shielding, the 10 gauge sheet metal shielding shall be overlapped at a minimum of 4-inches at every joint.

04. Designing Engineer(s) shall contact the University EH&S Office for details, if there should be any questions.

B. Transformers (Under 600 Volts)

01. General purpose distributing transformers shall be single phase and three phase dry type, which are generally used with primaries connected to secondary distribution circuits. They shall be designed for the voltage of 120, 208, 240, 480, and 600 with ratings ranging from 500VA to 5000KVA and frequency of 60 Hz.

02. The transformers shall be designed for continuous operation at the rated KVA for 24 hours a day, 365 days a year operation with a nominal life expectancy and greater overload capabilities in accordance with the latest ANSI-C57. The temperature rise of these energy efficient

transformers shall be 80 degrees C temperature rise and shall be insulated with a UL recognized 220 degree C insulation system. Transformers shall have K factor rating as recommended by current ANSI/IEEE standards, where required (i.e. computer center, lab, etc.). It shall have a 30 percent overload capability. Because of the growth of computer lab in all building and use of wireless computers throughout the University campus all general purpose transformers in renovations and new construction shall be K-rated transformers.

03. The transformers shall be designed for a low coil watt loss.
04. Coil and Core Assemblies:
    a. Transformer cores shall be constructed with high grade, non-aging, grain-oriented silicon steel with high magnetic permeability, low hysteresis and eddy current loses.
    b. Transformer coils shall be wound of electrical grade copper and continuous wound construction. The neutral conductor shall be rated to carry 200% normal phase current, when required.
    c. Enclosure shall be ventilated, heavy gauge sheet steel, primed and finished in gray baked enamel. The core and coil assembly of the transformers shall be impregnated with non-hygroscopic, thermosetting varnish and cure to minimize hot spots and seal out moisture. The core of the transformer shall be grounded to the enclosure.
    d. The sound levels of the transformer shall be designed in accordance with ANSI/NEMA recommended levels.
    e. Provide minimum clear working space of 3-1/2 feet about transformers operating at 600 volts, nominal, or less to permit ready and safe operation adjustment, repair and maintenance.
05. Transformers greater than 25 KVA shall not be mounted on or near the wall adjacent to an office, computer room or laboratory unless the wall is magnetically shielded.
06. Proper ventilation and cooling shall be provided at locations where transformers are installed to prevent temperature in the room to rise above 75 degrees F.
07. Wall or ceiling mounted transformers shall have the floor space below permanently accessible.
08. Shall be placed on a housekeeping pad no less than 4” thick.

LOW VOLTAGE SWITCHGEAR – SERVICE ENTRANCE

1. REQUIREMENTS
   - A. Protective Devices: Main breakers and feeder breakers or switches shall be equipped with ground fault protection as required by applicable codes. In critical applications provide coordinated ground fault protection on feeder breakers. Provide settings and coordination information with the service manuals.
     - 01. All circuit breakers with solid state trip units shall comply with the following standards:
       - a. ANSI/IEEE – Surge Withstand Capability (SWC).
       - b. ANSI/IEEE – Withstand capability of relay systems to radiated electromagnetic interference from transceivers.
     - 02. The maximum operating force required to open or close a switch or breaker shall not be greater than 75 pounds on the operating handle.
     - 03. Vacuum breakers or vacuum switches may be used with the approval of the University Electric Shop.
       - a. All switches shall be top or horizontal fed to the breakers.
     - 04. Indicator lamps shall be LED or transformer type utilizing low voltage lamps.
     - 05. Shall be placed on a housekeeping pad no less than 4” thick.

METERING (See division 33050)

1. REQUIREMENTS
   - A. Metering System: A meter with system display is required for each building, transformer, or service. Approved and acceptable meters and manufacturers for OSU facilities are:
     - 01. Power Management Ltd. shall be PML 7200 or PML 7700 with enhanced package #1, RS-485 and 480 volt power supply, if required.
     - 02. Each individual KWH meter specified must have communications and impulse capability.
     - 03. If complete meter setup cannot be done from the front panel, any required software, cables, and keys shall be provided to the Facilities Operations and Development Electric Utilities Shop.
     - 04. The height shall be five feet (5’-0”) from the finished floor or four and a half feet (4-1/2’) from the switch pad to the center of the meter.
     - 05. Provide four (4) current transformers and circuit monitor that indicate true RMS current for phase and neutral.
     - 06. The monitor shall provide the following information:
       - a. Voltage: phase to neutral and phase-to-phase ABC.

b. Amps: present reading and 15-minute maximum demand ABCN
c. Kilowatt maximum demand based on 15-minute intervals.
d. Power factor, kilo VAR, kilo VAR, hour KVA.

B. A 6-pole GE PK-2 panel-mounted test plug installed flush on switchgear for portable test metering by University Maintenance Personnel. Specify that three (3) left poles be factory wired to the phase current transformer secondaries; wire the right hand pole no. 6 to the phase to neutral potential source. Current transformer poles shall have shorting auxiliary contacts.

01. If the meter used for KWHR reading does not have a meter serial number on the front of the display, then an engraved name plate shall be installed below the meter with the meter serial number engraved on its.
02. Avoid metering schemes that are only capable of measuring partial loads connected to the distribution system or electrical apparatus being monitored. Specify that the current transformers and the meter shall be installed to measure electrical load from the distribution system including fire pumps. The fire pumps shall be connected ahead of the main overcurrent protective device.

SERVICE DISCONNECT

1. REQUIREMENTS

A. Fuses may be used in primary voltage services, and motor controls.

01. UL classification fuses shall be used as required for time delay and current limitation requirements of the application.
02. Fuses for feeders and branch circuits up to 600 ampere shall be UL Class RK1 or RK5 with 200,000 AIC.
03. Fuses for secondary service mains and feeders over 600 ampere shall be UL Class L with 200,000 AIC.
04. Spare Fuses: Specify that a spare fuse complement be stored on existing metal shelves, metal mounting boards, or in a cabinet in the electrical switchgear room and that a typewritten and framed bill of material be mounted nearby. There shall be no combustibles stored or kept near transformers. If there is no existing storage or additional storage space is required, specify that Contractor provide a cabinet equal to Bussman SFC.
    a. Spare fuse complement shall include a minimum of three or 10% of the total each (whichever number is greater) spare fuses of each class, ampere, and voltage rating installed, including primary fuses and control circuit fuses in switchgear and any equipment.

GROUNDING SYSTEM

1. REQUIREMENTS

A. Drawings and Specifications: Drawings shall show ground systems, protective conduit sizes and relative locations. Specifications and drawings shall include detailed requirements of the grounding system. A reference only to the National Electrical Code, without elaboration, has proven to be insufficient. Specifying requirements only by referencing the code is prohibited. It is required that the Designer/Engineer shall specify all requirements applicable, instead of referring only to National Electrical Code. This includes specifying the size and requirement of all electrode ground conductors used for connecting to the ground rounds, electrode grounds in the concrete, cold water pipe and between the neutral and the equipment ground. It also includes sizing all equipment ground conductors routed with the phase conductors. All sensitive electronic equipment (computer rooms, etc.) shall have single point grounding system originating at the service entrance ground.

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B. Transformer Grounds:

01. Building Service Transformers: Secondary neutrals shall be grounded separately from the neutral ground at the service main, unless close coupled in unit substation construction.

02. Low Voltage Transformers: Secondary neutrals shall be grounded in the low-voltage service equipment, as required by NEC for services.

C. Equipment Grounds: A wire equipment ground shall be installed within the branch circuit conduit and be grounded to the cabinet of the panelboard to an

uninsulated ground bus. The neutral bar of the panel shall not be used for equipment grounds.

01. Equipment grounds and the identified neutral shall not be electrically interconnected on the building side of the service ground.

D. Convenience Outlets: Specify that a wired ground be provided for continuity of ground path from the device-grounding pole. Provide ground fault interrupter outlets in wet conditions and where required by NEC and other related codes.

DISTRIBUTION

1. REQUIREMENTS

A. Design: If feasible and when unit substations are provided, the secondary main breaker shall be made a part of the building distribution switchgear or switchboard. In no case shall the switchgear or switchboard or panelboard be directly attached to the transformer. A minimum 12-inch transition section with solid barrier is required to reduce the transfer of transformer heat to the low voltage section. Reduction of heat transfer may be accomplished with secondary throat or ventilated transition section.

01. When double-ended substations are provided with tiebreakers, the tiebreaker shall be key interlocked with the main secondary disconnecting means requiring the spare key to parallel sections.

B. Equipment: Metal-enclosed switchgear or distribution boards shall be used in buildings or University Facilities at 600V and below for service entrance power, lighting distribution and as the secondary sections of unit substations. Main service disconnecting, 1200 amp and larger, devices shall be individually mounted and clearly labeled. Feeder devices in the main switchboard or switchgear shall be individually mounted. Feeder devices in distribution panelboards shall be group mounted. The following components shall be specified as required:

01. Service protectors
02. Molded case circuit breakers
03. Fusible switches
04. Motor starters
05. Low voltage AC power circuit breaker (generally limited to main or tie position)
06. Bolted pressure switches
07. Transfer devices or switches
08. Instrumentation, metering and relaying

a. Type of Molded Case Circuit Breakers: These devices are available in the following general types:
   1) Thermal magnetic dash pot
   2) Magnetic only
   3) Integrally fused
   4) Current limiting
   5) High interrupting capacity

b. It is required that all circuit breakers that are equipped with solid state trip unit must comply with low voltage switchgear protective devices of this Division.
   1) Air circuit breakers shall be draw out type, installed in individual compartments.
      i. Interrupting ratings of air circuit breakers and molded case breakers shall not be applied in “cascade”.
   2) The handle operating force on all equipment shall be 75 pounds or less.

C. Provisions for Additional Circuits:
   01. Size of Switchgear or Switchboard: Select a size that will provide sufficient spare spaces, complete with bus and hardware, for a reasonable forecast of future installation of circuits. A minimum of one fully bussed spare section shall be provided. Provide the following spare switches at the design stage:
      a. Four (4), 100-amp/3 poles
      b. Four (4) 200-amp/3 poles
   02. Additional Section: Provide space in the bus arrangement (bus ties) for the addition of future switchgear or switchboard sections. Switchgear and panelboards shall be accessible with a 4-foot minimum working clearance on all sides requiring access.

D. Instrumentation shall be per “Metering” section of this Division.

E. Service to Fire Pumps: Fire pumps shall be served and protected as required in NFPA No. 20.

F. Use switchboard instead of panelboard for emergency systems for the purpose of future growth and expansion. The switchboard shall be equipped with metering systems as required in “Metering” section of this standard.

G. When adding switches, circuit breakers, bus plugs or motor starters to existing equipment, the Designing Engineer shall include the following in the design documents:

01. The manufacturer's nameplate data including manufacturer and catalog information of the existing equipment.
02. If the equipment is no longer manufactured (i.e. Continental, Arrow Hart, Crouse Hinds, etc.) the Designing Engineer will contact a company that specializes in obsolete equipment and obtain the bidding information.
03. Design engineer will provide cost analysis to replace obsolete equipment with current technology.

GENERAL PURPOSE POWER AND LIGHTING CIRCUITS

1. REQUIREMENTS
   A. System Design: Design feeders for a voltage drop of not more than 2 percent between service entrance terminals and branch circuit breakers terminals with a capacity for 30 percent load growth above initial design, unless greater growth is designated by the University in the initial planning conference.
   B. Feeders: Feeder ratings shall not be such a large percentage of the main that coordination of time and current and interrupting capacities cannot be achieved.
   C. Wiring: Specify that all feeders be installed in galvanized rigid conduit or electrical metallic tubing. (EMT)

FEEDER CIRCUITS

1. REQUIREMENTS
   A. System Design: Design feeders for a voltage drop of not more than 2 percent between service entrance terminals and branch circuit breakers terminals with a capacity for 30 percent load growth above initial design, unless greater growth is designated by the University in the initial planning conference.
   B. Feeders: Feeder ratings shall not be such a large percentage of the main that coordination of time and current and interrupting capacities cannot be achieved.
   C. Wiring: Specify that all feeders be installed in galvanized rigid conduit or electrical metallic tubing. (EMT)

GENERAL PURPOSE POWER AND LIGHTING CIRCUITS

1. REQUIREMENTS
   A. Design branch circuits for a voltage drop of not more than 3 percent between the branch circuit breakers and the load. As a minimum, increase conductors a minimum of one size when 120-volt branch circuit home runs exceed 75 feet.
   B. Lighting circuits shall not be loaded to exceed 60 percent of panel breaker rating.
   C. Branch Circuit Panels: Panels for lighting, convenience outlets, small motors, and equipment shall be molded case circuit breaker type with thermal-magnetic trip and AC and DC ratings. Provide for spare circuits.

01. Breakers shall be 20 ampere, 1 pole breakers, mounted in the panel with either bolt-on or stab-on connections.
    a. Trip rating of breakers for lighting and general use convenience outlets shall be 20 ampere. Provide other sizes, to the OSU Electric Shop, as required for special loads.
02. Sub-Feed Breakers: Panels shall not have sub-feed breakers. If multiple panels are supplied from a long feeder, use sub-feed lugs or separate splice box with full size tap to panel mains.
03. When installing new branch circuit lighting panels on a project the following shall be considered:
    a. All new panels shall be 42 pole minimum. Designers shall provide each new panel with a minimum of 15% spare 20 amp single pole circuit breakers and 35% spaces. Designers shall design an additional panel when these minimums cannot be met.
    b. New panels shall be 200 ampere minimum for 208Y/120 volt, 3 phase, 4 wire service and 100 ampere minimum for 480Y/277 volt, 3 phase, 4 wire service. Do not provide 240/120 volt, 3 phase, 4 wire tapped delta systems. Where 240 volts is required use of buck/boost transformers is required.
    c. Any new or existing building with 3 phase service shall only have 3 phase panels provided.
04. 120/208 volt panelboards shall be designed to 50% fill and no more than 70% fill at completion of project. An additional panelboard shall be installed where these conditions cannot be met. All panelboards shall have a minimum of 4 spare conduits terminating in accessible space.

D. Power panels shall be equipped with molded case circuit breakers of adequate interrupting capacity.

MOTORS AND MOTOR CONTROLS

1. REQUIREMENTS

A. Related Work: Air conditioning chiller starters and fire pump controllers shall be specified with the equipment in Divisions 21 and 23. Wiring from switchgear or switchboard to this equipment shall be specified in Division 26.

B. NEMA and NEC Requirements:

01. Motors and motor control equipment shall conform to NEMA voltage ratings. A motor rated atr 230 volts may not be used on a 208V system. Designer shall specify a 208V motor or buck/boost type transformer to achieve the required 230V.

02. Motor branch circuit protective devices shall meet the all requirements of the current NEC.

C. Motor Control Centers: Class I, Type B with terminal strip terminations.

01. Locations: Centers shall not be located where ambient temperature could cause derating of overload devices.

02. Overload heater charts shall be furnished, mounted inside doors of cabinets or separately framed and mounted outside the equipment.

D. Reduced Voltage Starters: Motors, sizes shall be such that if the inrush current exceeds 40 percent of the building transformer rating. Motors shall be equipped with a variable frequency drive, reduced voltage starters of the closed transition auto transformer or star-delta type, or solid state soft start, or current ramp starters.

E. Operating Protection:

01. Certification by the motor manufacturer that motors meet the voltage requirements of NEMA.

02. Overload Relays: Polyphase motor controls shall be equipped with three (3) overload relays. Reduced voltage starters shall provide overload protection during the starting step.

03. Provide 20% spare starters of each size used and provide 25% spare positions for additional starters. Provide space on floor for one (1) additional section and appropriately sized spare conduit run from MSG to immediate area.

MOTOR STARTER APPLICATIONS

1. REQUIREMENTS

A. Starters for 600V and Below: The design must conform to ANSI/NEMA ICS2-1983 (26). This is a requirement for magnetic controller ratings of 115-575V. AC motor starters and contactors may be used for controlling the circuit to the motor. This standard requires that starters should be carefully applied on circuits and in combination with joint short circuit protective devices such as circuit breakers, fusible disconnects that will limit the available fault current and let through energy level that starter can safely withstand. This withstand must meet the requirements of ANSI/UL 508/1983 (29) and ANSI/NEMA ICS1-1983 (25), (26) which cover controls, systems and devices.

01. The starters shall not be used without an adjacent line switch, if unfused disconnect switch is used or installed; it must be close to each motor as much as possible. This standard forbids the installation of a remote

switch with lock arrangement, switchgear, switchboard or a unit in a control center.

02. Each starter will identify controlled device and its location and each motor shall identify its control.

EMERGENCY/STANDBY POWER SYSTEMS

1. REQUIREMENTS

A. All new buildings and major renovations shall include a back-up generator.

B. Alternate Power Sources: Where the interruption of electric power supply to a building would result in hazard to life or property, major loss of research or equipment, provision shall be made for a standby supply of power to be used in the event of failure of the normal supply. Details of the plans as they apply to the project shall be explained and included in the early design development submittal and conferences. If tie-in on existing circuit or feeder is not practical at present, provision shall be made for future tie-in. Emergency and standby power systems are of two basic types:

01. An electric power source set apart from the prime source of power operating in parallel that maintains power to the critical loads should the prime source fail.

02. An available reliable power source to which critical loads are rapidly switched automatically when the prime source of power fails (AC source).

C. Automatic Transfer Equipment: Reliable equipment and transfer switch must be specified. Where both emergency systems and standby power systems are provided, separate transfer switches shall be provided for each system. Refer to current NEC for system descriptions.

D. Emergency/Standby Systems: It is required that provision be made by designing an emergency system/standby power source supplied by:

01. Engine generator

02. Separate emergency source

E. Emergency generators shall be natural gas or diesel engines depending on the availability of natural gas and the size of the unit.

F. When an emergency lighting system or generator system is available, supplying either emergency or standby power, the lights, receptacles, and similar critical loads at the generator, all mechanical equipment spaces, in transformer, switchgear, switchboard or substation spaces should be connected to the emergency/standby system.

G. Electrical lighting and power equipment fed from an emergency/standby generator shall be identified red. In both public and non-public areas the

equipment shall have a distinctive warning sign and indicate the location of both sources of power.

H. An emergency/standby panelboard shall be provided for:
   01. Exit lights
   02. Minimal hallway and stairway lighting and telephone power.
   03. Fire alarms, building security equipment and fire protection systems; this does not eliminate the need for batteries. Batteries shall be tested to indicate amp hour availability. The manufacturer shall provide documentation that indicates conformance with repaired rating to the University.
   04. Elevators and elevator rooms.
   05. Emergency illumination shall be part of emergency lighting that shall include illuminating all required means of egress lighting, illuminated exit signs, stairwell lights, and all locations where emergency lighting must provide at least code required minimum illumination to allow easy and safe egress from the area involved. Inverter ballasts are prohibited.
   06. Electrical Service equipment room and mechanical room lighting.
   07. Generator enclosure space lighting.
   08. Building system equipment which is used to heat the building (to prevent freeze-up in the winter) to include heat pumps, condensate pumps, control air compressors and other equipment as may be designated by the Owner.
   09. MCC's that control fumehoods, sump pumps, condensate pumps, building control air compressors, and related equipment.
   10. Building automation systems
   11. Animal room exhaust

I. Wiring for emergency systems shall be in separate conduits. Specify that all emergency system junction boxes and covers shall be painted yellow.
   01. Switches for emergency lighting circuits shall not be accessible to the public.

J. Transfer Switch: Transfer switch is a vital part of the proper operation of the system. In addition to current carrying abilities, transfer switch must be able to withstand voltage surges to meet reliability requirements. Special consideration over normal circuit devices or breakers should be given to transfer switch because of its application requirements. Its design must include normal duty and fault current ratings of the switch. These play an important part of transfer switch application and protection scheme. It shall be capable of closing into high current, of fault currents without damage and withstanding severe duty cycle in

switching normal rated load. The design and operation of transfer switch must meet the requirements of this standard and the following all relavent current codes and standards. Provide a separate transfer switch for emergency loads such as exit lighting, egress lighting, fire detection, public safety communications, and fire protection pumps from standby or backup power loads. All transfer switches must be connected to a remote control switching device to enable starting the generator and transferring load remotely.

ELECTRICAL PROVISION FOR ELEVATORS

1. REQUIREMENTS
   - A. Wiring and Switching: Wiring shall be extended to heavy-duty lockable fused switches located in elevator machine room.
   - B. Emergency Circuit: An emergency circuit to the elevator machine room shall be provided for the elevator cab light, fan and equipment room.
   - C. Pit Installations: Refer to Division 14. A light, light switch and GFCI convenience outlet must be provided in the pit of each elevator, each on separate circuit.
   - D. Passenger elevators that serve mechanical rooms shall be connected to an emergency generator.

LIGHTING

1. GENERAL REQUIREMENTS
   - A. Lighting design shall use an appropriate combination of natural, area and task lighting with security type lights where necessary to meet appropriate Illuminating Engineer Society (or similar) recommendations. Efforts should be made to minimize electricity consumption from lighting by striving to reduce footcandle levels. Lighting should fit task-area requirements only. General-area lighting is to be selected at a lower intensity to accommodate access and non-critical sight needs.
   - B. All lighting will be provided with disconnecting means in acceptance with the current NEC.
   - C. Facilities Services requires replacement pricing for both ballasts and lamps, to be supplied at the design phase of the project and with the electrical submittals. (Design lighting projects to lamps currently in OSU Warehouse inventory.) For a list of lamps in inventory contact OSU Electric Shop. The use of self-luminous exit signs containing radioactive material is prohibited unless specifically approved by Environmental Health & Safety (EH&S).

2. FLOURESCENT LIGHTS
   A. Dimming control systems shall be reviewed and approved by OSU electrical shop.
   B. Reduced harmonic electronic ballasts, parallel wired for operation of one or two type T-8 lamps, shall be used wherever fluorescent lights are installed, except where special dimming ballasts are necessary.
   C. Lamps are to have low mercury content equal to or better than Philips Lighting "ALTO".
   D. WARRANTY
      01. Lamp system warranty: Four foot T8 lamps and ballasts shall be warranted up to 3 years (3 years for 24,000 hour lamps), from the date of substantial completion of the project. Lamps shall have an 85 CRI index, maintain a 24,000 hour warranty and have a 2,850 lumens specification.
      02. Lamp warranty: See fluorescent mortality curve for normal lamp mortality. Defective lamps or lamps failing at a higher than normal rate shall be replaced after a factory inspection determining the cause of failure or defect.
   E. Worldwide Color standards: Color coordinates shall follow the proposed IEC/ANSI color standards regardless of the country of manufacture. Campus standard is 41K.
   F. Cathode construction: The lamp shall contain cathodes designed for specific operation on United States ballast operating systems (instant rapid, programmed start) regardless of country of manufacture.
   G. ANSI standards: Lamps shall comply with applicable ANSI standards.
   H. See the end of this section for information on parking lighting and historic fixtures.
   I. Areas under construction shall have temporary lighting for nighttime.
   J. All interior light fixtures shall be accessible by a step ladder, 8’ or less, placed in accordance with OSHA standards or one of the following:
      01. A permanently installed means of access.
      02. A building specific means (supplied by the project) of access (platform lift, etc.) stored in a readily accessible location on site and in place, at the completion of the project.
   K. All exterior lights shall be accessible by means currently owned by OSU without damage to buildings or plantings. Exterior lights must be installed an operated to prevent “up lighting” into the night sky, as per the Campus Master Plan.
   L. Fixtures incorporating lamps, other than those listed in facilities services warehouse inventory, shall not be used unless a written request to waive this

requirement has been approved by the OSU Project Manager and OSU Electric Shop.

01. For unique lamps and ballasts, 10% or 10 each, lamps and ballasts, whichever is greater, to be added to the OSU Stores inventory by the project. Inventory to be added by project commissioning.
02. Fixtures that require use of proprietary lamps and ballasts and do not allow use of lamps or ballasts from other manufacturers are not allowed.

M. All recessed can luminaires shall be 120 volt and have self ballasted lamps (10% lamps to be added to the "Stores" inventory by the project.)

N. T-8 fluorescent lighting systems shall utilize high performance ballasts and lamps, meeting Energy Trust of Oregon specifications for High-Performance T-8 Lighting Systems.

3. ELECTRONIC BALLAST

A. PERFORMANCE REQUIREMENTS

01. Ballast Factor: Ballast factors at nominal voltage shall be as follows:
    a. Standard ballasts - 0.90 ballast factor.
    b. PLUS ballasts - 1.2 for 2 lamp ballast.
    c. Flicker: Ballast shall operate lamps at a frequency above 20 KHz and lamps shall have no detectable flicker.
    d. Power Factor: Ballast shall have input power factor above 97% when used with primary lamp type.
    e. Harmonic Distortion: Ballast shall have Total Harmonic Distortion (THD) of 20% or less when used with primary lamp type.
    f. Current Crest Factor: Lamp current crest factor shall be 1.7 or less.
    g. Ballast Efficacy Factor (BEF): The relative light output per watt consumed shall be equal to or greater than a CBM certified electromagnetic ballast for the same application. Lamp Life: The ballast shall provide lamp starting conditions and parameters consistent with lamp manufacturer's recommendations and shall provide full rated lamp life under normal conditions.
    h. Circuitry: The ballast circuit shall operate lamps in parallel, such that if one lamp fails, others will remain lit.
    i. Starting Method: Ballast shall match lamp usage for maximum efficiency.
    j. Starting Temperature: The electronic ballast shall provide for a minimum lamp starting temperature of 0°F depending on the ballast model and installation conditions.

k. Ballast Output: The ballast output shall be protected against lamp rectification or shorted output leads.

l. Case Temperature: The ballast shall have a maximum case temperature rating of 70°C.

m. Internal Protection: The ballast shall have internal protection to prevent catastrophic failure.

n. Ballasts shall be universal 120V/277V input.

02. No fluorescent dimming balasts will be allowed.

4. PRODUCT SPECIFICATION

A. REGULATORY REQUIREMENTS

01. UL, CSA and CBM listing: The electronic ballast shall be Underwriters Laboratories (UL) listed, Class P, Type 1. CSA and CBM certified (where applicable).

02. EMI / RFI: Ballast shall meet FCC standard for EMI/RFI (FCC 47CFR Part 18 Non-consumer), ensuring suitability for both commercial and industrial installations.

03. Efficiency Standards: Ballast shall comply with all applicable state and federal efficiency standards.

04. Transient Protection and Harmonic Distortion: Ballast shall comply with applicable ANSI and IEEE standards for harmonic distortion and line voltage transient protection.

05. Sound Rating: Ballast shall have audible noise rating of Class A.

B. OTHER

01. Warranty:

a. The manufacturer shall provide a written warranty against defects in material or workmanship, including replacement, for 5 years from date of project commissioning and include a nominal replacement labor allowance.

02. If the lamp and ballast are covered by a combination lamp/ballast warranty; covered ballasts shall carry a five year warranty, from the date of installation, plus an additional year if the lamps are replaced with the same type, and kind, at time of relamp, and include a nominal replacement labor allowance. Covered lamps shall carry a 2 ½ year warranty (3 years for 24,000 hour lamps), from date of substantial completion installation. Lamps shall have an 85 CRI index maintain a 24,000 hour warranty, and have 3000 lumens specification.

1. LIGHT LEVELS – GENERAL:
   A. All new lighting installations at the University shall comply with the latest version of ANSI/ASHRAE/IESNA Standards. The referenced light levels are understood to be a maintained light level. Light levels are measured at a 30-inch height from the floor or at the actual work surface and represent the average level for the area or workstation.
   B. Special lighting applications such as recreational field lighting shall comply with the latest Illuminating Engineering Society (IES) standard.
   C. Student Study Areas and Classrooms: Provide 40 to 60 footcandle light level at workstation. Workstations equipped with video display terminals (VDT's) or computers should be illuminated with 30 to 50 footcandles as recommended by the latest edition of the National Institute for Occupational Safety and Health (NIOSH) standards.
      01. Switching in classrooms shall provide for switching the fixtures in the front and seating area separately to facilitate the use of overhead projectors, etc.
      02. Light fixtures at workstations with video display terminals or computers should be located perpendicular to device in order to minimize glare and viewing difficulty.
   D. Staff and Faculty Office Workstations: Provide 40 to 50 footcandle light level at workstation.
   E. Workstation Where Critical or Fine Work is Performed, as in Laboratories or Drafting Rooms: Provide 50 to 70 footcandle light level.
   F. Corridors, Stairwells, Lobbies, Waiting Rooms, Storage and Service Areas: Provide 10 to 20 footcandle light level.
   G. Rest Rooms, Lockers and Showers: Provide 20 to 30 footcandle light level.
   H. Lecture Hall and Auditorium Lighting: Provide 40 to 60 footcandle light level at all seating locations. For a lecture hall stage area, provide 40 to 60 footcandle light level. For an auditorium stage area, the lighting shall comply with the latest IES standard or as directed by the University Architect. Provide separate switching for stage and seating area.
   I. Parking Ramp Interior: Provide 1 to 3 footcandle light level in the traffic lanes, 1 to 3 footcandles in the parking areas, and 1 to 3 footcandle light level at the entrance/exit. All values are average maintained horizontal footcandles. Uniformity shall be 10:1 for the entire area. HPS shall not be used in parking structure.

J. Outside Security, Building Perimeter, Parking Lot and Outside Walkways: Provide 1 to 3 footcandle light level.

K. Outdoor lighting levels shall be designed as follows:

01. Primary walkways and problem areas: 1 footcandles average and .5 footcandles minimum.

02. Secondary walkways and other areas: .5 footcandle and .10 footcandle minimum.

03. Primary streets: 2 footcandles average and .25 footcandle minimum.

04. Parking lots: 1 footcandle average and .25 footcandle minimum.

L. Temporary Site Lighting During Construction: Sufficient lighting shall be provided such that Campus Police may observe the entire area. Provide a light level of 1 to 3 footcandles. The Contractor is responsible for providing temporary lighting outside of the project area if the project interrupts the normal lighting to the area.

M. Mechanical Rooms: Provide 50 to 60 footcandle light level. Mechanical room fixtures shall be “turret style” industrial fluorescent fixtures with wire guards. Sockets shall be protected by housing and shall not be exposed. Provide emergency egress lighting.

INTERIOR LIGHTING

1. REQUIREMENTS

A. Recommended Fixtures: Fluorescent fixtures using 4 foot T8 lamps are generally preferred. Compact florescent lamps should be used in canned fixtures. Incandescent lighting may be used only with the written permission of the University Electric Shop. Any department requesting approval of incandescent lighting must be willing to accept financial responsibility for the maintenance of the incandescent lighting. Where incandescent lamps are used as part of an equipment system or alarm, provide six (6) spare lamps of each wattage.

01. High pressure sodium (HPS) lamps shall not be used indoors. For warehouse areas and high ceilings, higher than 20 feet, T-5 high output reflective fluorescent lighting fixtures may be used.

02. Metal halide lamps shall only be used in areas where there is assurance that they will be turned off at least once a week; this reduces the possibility of an explosion at end of life. Their use should be limited to areas in which network television coverage is expected, accurate color rendering is required, or gymnasiums.

03. Fluorescent Fixtures: All fixtures shall be independently supported from the structure above. Fixtures shall be all metal with hinged shielding

louvers. Recessed fixtures with hinged frame open louvers may be used where required for architectural effect. 277-volt fixtures shall be used, except recessed luminaries, where this voltage is available. Fixtures shall meet or exceed the requirements of the latest version of ANSI/ASHRAE/IESNA Standards.

04. Quartz lamp fixtures shall not be used.
05. LED luminaires shall only be installed with OSU Electric Shop approval.
06. Ballasts: High frequency electronic type, specifically designed to use T8/T5 lamps, instant start, to operate multiple lamps in a parallel configuration. Ballasts shall meet minimum performance standards as established by the Certified Ballast Manufacturers Association. Additional requirements shall include a maximum total harmonic distortion of 20 percent, sound rating of "A", shall comply with applicable standards as set by ETL, FCC, NEC, IEEE, be listed by UL and carry a 5-year replacement warranty. Separate ballasts should be provided for each lighting fixture. For applications where one ballast is used to light multiple fixtures, the location of other fixture shall be identified. (Ballast selection shall be based on its designed usage; programmed start vs. rapid start.)
07. Ballasts for compact fluorescent lamps shall be electronic type and shall have the following characteristics:
    a. Ballasts to be high power factor type.
    b. Ballasts factor shall be .95 or greater.
    c. Ballasts for multiple lamps shall be parallel wiring type.
    d. Minimum starting temperature shall be 0 degrees F.
    e. Ballast shall contain end of lamp life fault mode shutdown protection.

B. Lenses shall not be specified as an alternative for louvers. If lenses are required for the job, the job shall be engineered for these units.
C. Fluorescent Lamps: 4-foot, 32-watt and 2-foot, 17 watt, T8, instant start/programmed start lamps with color temperature of 4100K and minimum CRI of 85.
D. Specify the use of exit signs utilizing Light Emitting Diodes (LED) light source with life expectancy greater than ten (10) years.
E. Incandescent Lamps: When approved by the University, specify the 130-volt, inside frosted lamp for rough duty application.
F. Lighting Safety: Stairwells in buildings shall have sufficient fixtures so that the loss of one lamp or ballast will not leave the area dark. The mounting of the fixtures shall not be at the extreme height but must be accessible for

maintenance. Fixtures shall be positioned, only on the side walls, over landings', at a maximum height of 8-feet. Fixtures shall have lenses; no bare lamps shall be permitted. Stairwell lighting circuits shall be fed by e-panels from a generator (if available.)

G. Provide the following spare parts with the listed quantities for compact and T8/T5 fluorescent fixtures for each item and size required:
   01. Ballasts: 5%, minimum of 3 of each type.
   02. Lamp Sockets: 10%, minimum of 10 of each type.
   03. Fixture Lenses and Supporting Hardware: 10%; minimum of 10 of each type.

H. All submittal reviews for luminaires and ballasts shall include the following:
   01. Catalog cut sheets and replacement costs.
   02. Lists of spare parts with quantities to be furnished.

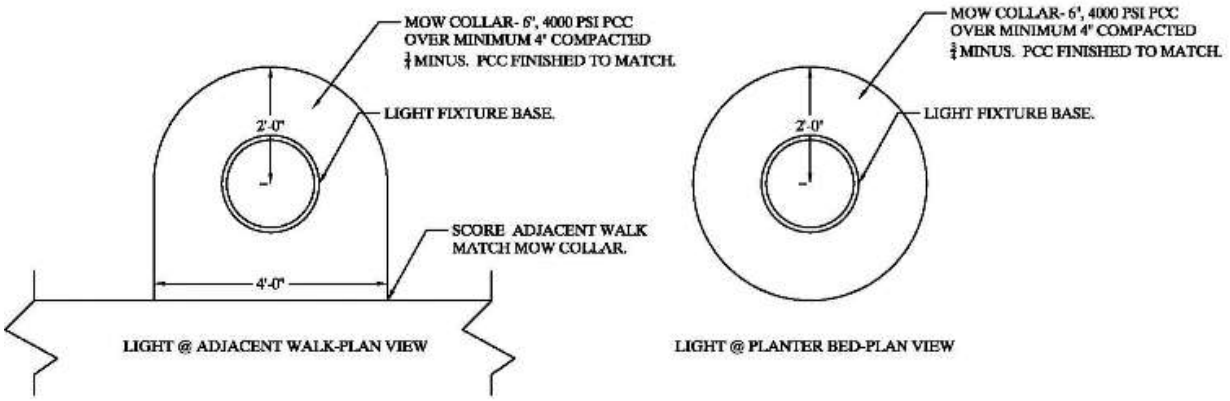
EXTERIOR LIGHTING

1. REQUIREMENTS

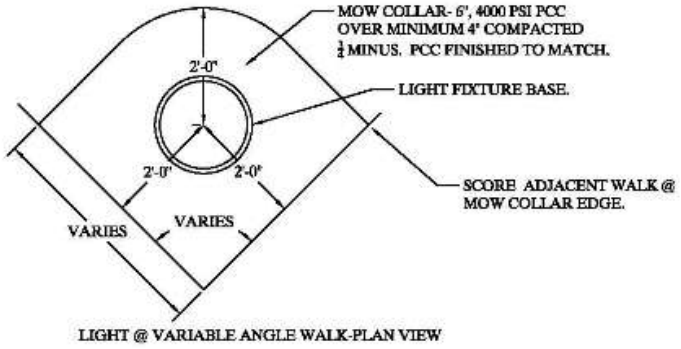
A. Lighting for the entire site, including driveways, walks, parking areas and the building perimeter shall be included in the contract documents.

B. Fixtures: High intensity discharge (high pressure sodium lamps) fixtures mounted on the building or on suitable standards are required for all exterior site lighting. These fixtures shall be automatically controlled by photocell(s) and/or the automated building management system and also have an accessible bypass.
   01. Light control shall be provided on all exterior lighting fixtures. The fixture shall be insect proof. Vandal proof fixtures shall be used if the fixtures are mounted 10 feet or less off the ground.
   02. Parking Lot Light Fixture
      a. Architectural Lighting ALR 182 or KIM CCS, 21" diameter, multi-tap ballast, 150w HPS, 20' round tapered steel pole, light gray color.
      b. Fixture Park Circle Series. Bieber Lighting Corporation. PC-2-J1-MT-L-S-H-GY-Yoke Mount.
      c. Fixture: PC> Size: diameter – 23".
      d. Light source: HPS = J1, 150W. Voltage: multi-tap transformer.
      e. Optics: Type 5.
      f. Mounting arrangement: 2" Tenon fitter.
      g. Color: gray.
      h. Options: Slip-fit fixture arm.

03. Historic Light Fixture
    a. See the Campus Master Plan for down lighting requirements
    b. Visco Series A
    c. Cast iron base, 12’ tapered, fluted steel pole, (14’-2” plus or minus 1” to lamp centerline),
    d. Multiap ballast,
    e. 70w HPS Mogul base lamp with two piece polycarbonate globe,
    f. Prismatic Glass Refractor 4685 Type III optional reflector, band, finial, and downlight reflector/louver.
    g. Available through Valley Iron and Steel Co. (VISCO) 29579 Awbrey Lane, Eugene, Oregon 97402-9639, Phone (541) 688-7741.
    h. Shall be painted “OSU Black”: Benjamin Moore #80 6403-23028; 50% gloss.
    i. Lay out must be in straight lines adjacent to walkways.
    j. Must have 24” radius concrete collar (see diagrams).
    k. Provide an extra conduit for future capacity at every fixture. Extend conduit beyond footing and adjacent concrete so it can be easily accessed in future.



NOTE: REFER TO ELECTRICAL, EARTHWORK, AND CONCRETE DIVISIONS REGARDING CONDUIT, ANCHORS, EXCAVATION AND BACKFILL AND CONCRETE



C. Fixture Location: Fixtures shall be located in such a manner that dark voids and excessive glare in windows are eliminated. Accessibility for servicing must be considered in locating fixtures. All fixtures shall be accessible by means currently owned by OSU Facilities without damage to landscape or plantings. Consideration must also be given to light spillage onto adjacent facilities (existing or planned) such as greenhouses, which are light sensitive. Use directional or shielded lighting as necessary to prevent light trespass.

D. Fixture Location: Fixture locations shall be designed in concert with the Landscape Architect so as to prevent future blocking of fixture by vegetation.

2. LIGHTING CONTROLS
   A. Automated lighting controls that minimize electrical lighting use are required in all areas. Automated lighting controls shall not be used where safety may be jeopardized, i.e. stairwells, labs, kitchens, mechanical spaces, restrooms.
      01. Exceptions may be submitted to OSU Electrical Shop for review. ‘

LIGHTING CONTROLS
1. REQUIREMENTS
   A. Multiple Switching: The use of multiple switching shall be evaluated for each space and condition. Where possible, switching shall be circuited to effectively use natural lighting from windows; to permit light reduction during partial occupancy; and to permit reduced lighting for custodial activity.
   B. Occupancy sensors shall not be used as the sole means of switching. Manual switches will be provided in all areas with occupancy sensors. Occupancy sensors shall not be used in mechanical rooms or other areas where safety would be jeopardized. At installation, set all sensors to maximum sensitivity and maximum time delay. Use manual on / auto off where applicable.
   C. Remote switching by means of a central control should be evaluated for new construction and for large renovation projects.
   D. Dimming Control: Access to dimming controls shall be readily accessible at all times without escort of other departmental personal.
      01. Where dimming is required it shall be used to control incandescent lighting and may be used for Hi-Lume and approved solid state dimming ballast fluorescent fixtures for low lighting levels. The control panel/panels required for the dimming system shall have the UL label. Each dimming module shall be UL tested and tested specifically for the type of load it is controlling. Each dimmer module shall possess a means of easily disconnecting power on an individual module-by-module basis.
      02. Dimming panels shall be cooled without the use of cooling fans with no exception and shall be capable of operating as such in an environment of 0 degrees to 40 degrees centigrade. Satisfactory independent laboratory test results shall be required, that a +40 degree centigrade and at full load, the maximum temperatures of both filter chokes and SCRs/Triacs are not exceeded.
      03. There shall be one air gap positive off relay for dimmer, either integral to the dimmer or mounted elsewhere in the same panel. Other advanced technological approaches that give the same or better operational result is highly recommended by this standard.

04. All controls shall have the capabilities of reverting back to their previous status after any duration of power outage (power failure memory), without the use of any type of rechargeable or trickle-charge type of battery.

05. All systems must be submitted to the OSU Facilities Electric Shop for approval.

a. Special Requirements for Fluorescent Dimming Systems: Before specifying fluorescent dimming systems, the Designer shall consider the following:

1) 100 hour “burn-in” time is required for the fluorescent lamps when using the dimming ballasts.

2) The cost of replacing the ballast and lamps when needed is 200-300% more than replacing standard systems.

b. This standard requires the Designer to review the application of dimming devices and submit recommendations to Facilities Electric Shop before incorporating into specifications.

E. Parking ramp interior lighting shall be circuited to permit lighting of dark interior areas during the day without lighting those areas which receive sufficient natural light. Automatic control of ramp lighting by photocell is required.

F. All exterior area and security lighting shall be dusk on and dawn off, powered from one location in the building and controlled from the photo control, with provisions for manual override. Photo cell shall be readily accessible. Time clock control may be used on exterior or security lighting with written approval of the Facilities Electric Shop.

G. All lighting controls shall be located so as to have 24/7 access without escort of departmental personnel.

WINDOW OPERATORS

1. REQUIREMENTS

A. Window Operators: First choice is the model stocked by Facilities Services Stores.

Section 28 30 00 – FIRE DETECTION & ALARMS

PART 1 - GENERAL

1. REQUIREMENTS
   - A. The following guideline is established to aid the Engineer of Record during the design process including the development of drawings and specifications. Contents and requirements staled herein are to be incorporated as required into the final contract documents prepared by Engineer of Record for a specific project.
   - B. Fire Alarm Systems shall be specified in Division 16 and the installation shall be by an approved contractor certified by the manufacturer. Fire alarm systems shall be designed by a NICET IV Engineer, Electrical Engineer, or by a State of Oregon Electrical Supervisor whose primary workload is designing and installing fire alarm systems.
   - C. The Corvallis Fire Department is the Authority having jurisdiction (AHJ) for code compliance. City of Corvallis Construction Office is the Authority having Jurisdiction (AHJ) for construction administration, inspection, and acceptance.
   - D. Fire Alarm systems shall meet all code requirements of NFPA 70, NFPA 72, Oregon State, City of Corvallis, and Corvallis Fire Department. Upon completion the system shall be 100% fully tested and certified in accordance with NFPA 72 Record of Completion document.
   - E. Oregon State University Facilities Planning and Design (OSU-FP&D) manages the document process, and coordinates design reviews and meetings between Engineer of Record, OSU Construction Management and OSU Facilities Operations Alarm shop representative.
   - F. Oregon State University Management (OSU-CM) manages the construction and commissioning of the fire alarm system. OSU-CM coordinates review of submittals with OSU-FP&D and OSU Facilities Operations Alarm Shop Representative.
   - G. Oregon State University Construction Management requires the Fire Alarm Contractor of record to demonstrate to the satisfaction of OSU Construction Management the system has been fully tested.

2. ENGINEER OF RECORD'S RESPONSIBILITIES
   - A. The Fire Alarm System design and installation shall comply with requirements of the latest edition of the following codes or standards:
     - 01. NFPA 70 *National Electric Code*

02. NFPA 72 *National Fire Alarm Code*

03. Oregon State University *Fire Alarm System Standards* located below as Part 3 of these design guidelines.

B. *Oregon State University Fire Alarm Standard*. Part 3 hereinafter, provides supplemental requirements of Fire Alarm Systems installed in Oregon State University facilities. The Engineer of Record shall incorporate project specific requirements of Part 3 and into the written specifications and drawings of the project.

C. The Engineer of Record shall be responsible for the design of a fire detection system that is fully serviceable by the university and can be U.L. certified as installed. The Engineer's design shall fully comply with *Oregon State University Fire Alarm Standard;* all deviations shall require written approval from the University.

D. The Engineer of Record and OSU Project Manager shall conduct a "pre-design meeting" with a representative of and OSU Facilities Alarm shop. The Facilities Alarm shop maintains fire alarm systems for OSU. The purpose of this meeting is to insure Engineer of Record understands OSU's project specific requirements.

E. The Engineer of Record shall insure installation meets NFPA 72, chapter 6 Requirements for Notification Appliances for Fire Alarm Systems. Engineer of Record may use a performance specification to insure compliance. However, the minimum quantity of notification appliances shall be as shown on plans and risers.

F. The Engineer of Record shall insure the FACP or annunciator, when applicable, is to be mounted at the main entrance to the facility (designated emergency entrance). Annunciation of all building alarms shall occur in one central location, such as central room, loading dock, or central entrance. This includes fire, ventilation failure, and gas monitor alarms.

G. The Engineer of Record shall insure the FACP or annunciator, when applicable, is to be mounted at the main entrance to the facility (designated emergency entrance). Annunciation of all building alarms shall occur in one central location, such as central room, loading dock, or central entrance. This includes fire, ventilation failure, and gas monitor alarms.

H. Minimum acceptable audible signals shall have a sound level l5dbA above average ambient as defined by NFPA 72. Additionally, audible signal shall have a minimum sound level of 75 dba 10 ft. from appliance but sound level shall not exceed l35dbA at minimum hearing distance. Engineer of Record may use a

performance specification to insure the required audible signal levels are achieved.

I. Fire alarm signaling to follow the National Fire Protection Association (NFPA 72) section for all new construction and remodel projects. Adequate design must account for anticipated background ambient noise, wall partitions, and other obstructive features. Testing results of the alarm system to meet this code must be submitted to the University's project manager as part of the commissioning and/or final sign-off process".

J. The Engineer of Record shall insure installation meets the current edition of NFPA 72, Requirements for Notification Appliances for Fire Alarm System's. EOR may use a performance specification to insure compliance. However, the minimum quantity of notification appliances shall be as shown on plans and risers.

K. The Engineer of Record shall submit shop drawings of the fire alarm system to OSU for review. Included shall be the contractor's prepared plan drawing showing devices, system riser, point-to-point circuiting interconnecting all devices, candela ratings for all visual devices end-of –line resistors, addresses of all addressable devices, circuit numbers for notification device and manufacturer's specification sheets. Drawings shall include design ambient sound level, audible alarm device sound power and alarm sound level for each space or contractor shall certify that design meets NFPA 72 for sound levels. Any additional devices required shall be at contractor's expense.

01. Addressable Horn: Addressable horn shall be listed to UL 464. Horn appliances shall have a High/Lo Setting, programmable by channel from the addressable controller or by appliance from the host FACP. The horn shall have a minimum sound pressure level of 83 or 89 dBA @ 24VDC. The horn shall mount directly to a standard single gang, double gang or 4" square electrical box, without the use of special adapter or trim rings. Appliances shall be wired with UTP conductors, having a minimum of 3 twists per foot.

02. Addressable Visible/Only: Addressable strobe shall be listed to UL 1971. The V/O shall consist of a xenon flash tube and associated lens/reflector system. The V/O enclosure shall mount directly to standard single gang, double gang or 4" square electrical box, without the use of special adapters or trim rings. Appliances shall be wired with UTP conductors, having a minimum of 3 twists per foot. V/O appliances shall be provided with different minimum flash intensities of 15cd, 75cd and 110cd, selectable settings via the fire alarm control panel. Provide a label inside

the strobe lens to indicate the listed candela rating of the specific Visible/Only appliance.

03. Addressable Audible/Visible: Addressable combination Audible/Visible (A/V) Notification Appliances shall be listed to UL 1971 and UL 464. The strobe light shall consist of a xenon flash tube and associated lens/reflector system. Provide a label inside the strobe lens to indicate the listed candela rating of the specific strobe. The horn shall have a minimum sound pressure level of 83 or 89 dBA @ 24VDC. The audible/visible enclosure shall mount directly to standard single gang, double gang or 4" square electrical box, without the use of special adapters or trim rings. Appliances shall be wired with UTP conductors, having a minimum of 3 twists per foot. The appliance shall be capable of two-wire synchronization with one of the following options:
    a. Synchronized Strobe with Horn on steady
    b. Synchronized Strobe with Temporal Code Pattern on Horn
    c. Synchronized Strobe with March Time cadence on Horn
    d. Synchronized Strobe firing to NAC sync signal with Horn silenced

L. In lieu of using duct mounted smoke detectors and where allowed by the code, the Engineer of Record shall design a complete smoke detection system less duct detector. The Fire Alarm System shall comply with all applicable codes.

M. The Engineer of Record shall review specific vender requirements with OSU and where requirements dictate specific vendor/equipment, the Engineer of Record shall assist OSU in open meeting requirements to allow bid alternates. The Engineer of Record shall prepare contract documents requiring alternate bids to be taken for the fire alarm systems listed in Section 3.

N. The Engineer of Record shall insure continuous alarm protection when designing fire alarm systems where upgrading, modifying or phasing of work is required. Fire alarm protection shall be maintained in occupied areas of a building at all times. A construction phasing-plan shall be prepared by the Engineer of Record and shall be included in specifications whenever portions of the construction site shall be occupied prior to final inspection. The University's desire is to keep all life safety systems operating at all times. The Engineer of Record shall use all available means to avoid the need of disabling fire alarm systems.

O. The Engineer of Record, prior to accepting the fire alarm shop drawing package**,** shall conduct a mandatory "fire alarm review meeting" with the OSU construction management team and OSU Alarm shop. The electrical contractor and fire alarm contractor shall review the fire alarm shop drawing package with

OSU. The purpose of this meeting is to insure contractor complies with OSU's site specific fire alarm and detection installation requirements.

P. The Engineer of Record shall conduct a mandatory "pre-construction meeting" with the electrical contractor, the fire alarm contractor and the OSU construction management team. The purpose of this meeting is to insure OSU understands the contractor's installation plan and the contractor understands OSU's site-specific requirements.

Q. Oregon State Construction Office requires, prior to final inspection**,** the Engineer of
Record to verify the fire alarm contractor has fully tested and certified the system in
accordance with NFPA 72 and shall sign NFPA 72 Record of Completion. The panel shall be labeled by the testing person(s), with signature and date.

R. At the same time as the verification described by 2.11, above, or prior to final inspection, the Engineer of Record, shall require Fire Alarm Contractor to demonstrate 100% compliance with plans, submittals, specifications and NFPA 72.

S. The Engineer of Record shall submit shop drawings of the fire alarm system to OSU for review. Included shall be the contractor's prepared plan drawing showing devices, system riser, system interconnection drawings, and manufacturer's specification sheets. Drawings shall include design ambient sound level, audible alarm device sound power and alarm sound level for each space or contractor shall certify that design meets NFPA 72 for sound levels. Any additional devices required while veering the system shall be at contractor's expense.

3. Oregon State University Fire Alarm Standards

A. The following guidelines apply to all new installations of Fire Alarm System's in facilities owned by Oregon State University. These guidelines cover both new facilities and/or renovations to existing facilities. These guidelines shall be incorporated into design documents and shall be project specific.

B. Fire detection systems are an integral part of protecting life and property. These guidelines have been developed for use in the design and installation of these critical systems and to insure the University receives a reliable system that meets all applicable codes.

C. GENERAL REQUIREMENTS

01. FACP shall be wired to building LIFE SAFETY EMERGENCY POWER with circuit labeling placed on FACP faceplate upper right hand corner including FACP indicated on panel circuit schedule.

02. INITIATING DEVICES:

a. ALL FIELD DEVICES shall be programmed with individual addresses.

b. ALL MONITORING/SUPERVISORY DEVICES shall be programmed with an individual address.

c. ALL PHOTOELECTRIC SMOKE SENSORS shall be intelligent analog type detectors.

d. ALL THEMRAL SENSORS shall be intelligent analog type detectors.

e. ALL PROJECTED BEAM SMOKE DETECTORS will have local key operated testing stations accessibly mounted (test switch to be mounted no higher than 72”)

f. ALL DEVICES LOCATED ABOVE CEILINGS shall have a remote LED indicator mounted on the wall at eye level as near as possible below the device and labeled accordingly.

g. ALL DEVICES MUST BE INSTALLED WITH GOOD ACCESS FOR SERVICING.

h. ALL HEAT AND SMOKE DETECTORS SHALL HAVE WIRED BASES.

03. The activation of any smoke detector shall initiate an Alarm Verification operation, whereby the panel will reset the activated detector and wait for a second alarm activation. If, within one (1) minute after resetting a second alarm is reported from the same or any other smoke detector, the system shall process the alarm immediately. If the second alarm doesn’t occur within the Alarm Verification time window, the system shall resume normal operation. The time period for the Alarm Verification reset shall be programmable from 1 to 60 seconds. The Alarm Verification operation shall occur on smoke detector alarms. The Alarm Verification operation shall be selectable by device, not just by zone.

04. All smoke detectors shall have magnet test capability if available for installed system. All smoke detectors shall be photoelectric. Ionization devices will not be allowed. All smoke detectors shall set to a minimum 2.5 % obscurity. If the device is adjustable to a higher obscurity, the highest setting shall be set upon installation.

05. Each initiating device (smoke detectors, heat detectors, pull stations, duct detectors, NAC panels, etc…) shall have its own unique address. Devices are to be visibly labeled with its address following section 3.10.7.0. Full detector SENSITIVITY and device SERVICE STATUS reporting.
06. Smoke detection shall never be installed in:
    a. Laboratory fume hood exhaust,
    b. Maintenance or mechanical areas,
    c. Attics, exterior of buildings, or any location where temperature may be below 40F or above 100F, or where high humidity, dust, insects or airborne particulates might be present.
07. NOTIFICATION APPLIANCES:
    a. ALL VISUAL NOTIFICATION APPLIANCES will be synchronized with all others in a given area. ALL VISUAL NOTIFICATION APPLIANCES shall be Addressable 2 Wire Type. ALL PERIPHERAL DEVICES shall be powered from the building emergency power circuit and battery backed.
    b. ALL Horns shall be Addressable 2 Wire Type.
    c. ALL Notification Appliance Circuits (NAC) power extenders shall be approved by FACP manufacturer, support full monitoring and meet all NFPA requirements.
    d. ALL NAC POWER EXTENDERS shall be installed next to the main FACP; all other installation locations must be approved by OSU Alarm Shop. NAC must be connected to E-Power source.
    e. NAC all NAC supplies shall be labeled by NAC number and circuit number including type of circuit for area served (i.e. NAC 1 Circuit 2 Horns) must be connected to E-Power source.
    f. ALL NAC POWER EXTENDERS shall be monitored by an assigned individual addressable monitoring point for each extender with descriptive annunciation programmed for that device on the main FACP and remote LCD annunciator display.
08. AUXILLARY DEVICES:
    a. ALL FAN SHUTDOWN RELAYS shall be addressable monitored devices that may be bypassed at the main FACP, and locally indicate the operational state (status LED on control relay shall be at or near eye level) of the relay. All shutdown controls shall be wired to the normally open, held closed, contacts during normal status (no Alarm) of the FACP. ALL SMOKE VENT RELEASES shall

have associated service bypass control switched from the main FACP front panel.

b. ALL SMOKE VENT RELEASES will utilize 24 volt reset-able latching devices only, and shall be battery backed by main FACP or auxiliary supply. Fusible links shall not be a primary releasing mechanism and no ETL links will be used.

c. ALL DOOR HOLDER CIRCUITS shall be 24 Volts and be on separate dedicated power supplies and have associated service bypass control switched from the main FACP front panel. Having separate power supplies for Door Holders prevents loss of main power supply due to a shorted Door Holder circuit.

d. Installation, hardware, and programming shall support all functions associated with a walk test. During a walk test, horn and strobe functionality shall be supported while testing devices using the walk test with signal feature. Devices and wiring methods that do not support testing in walk test mode with a signal having full functionality of that feature are NOT acceptable.

e. All duct smoke detectors and/or linear beam smoke detectors shall have a Remote Alarm Indicating Light (RAIL) with a test switch. Test switch shall be mounted 8-0" A.F.F. in a common area ex. Main Corridor. Duct detectors shall report as a supervisory, not alarm when activated.

f. Fire/smoke dampers are to have individual over current protection and disconnect. The fuse shall be sized for 125% for non-impedance protected motors and 200% for impedance-protected motors. The combination over current /disconnect means shall be located within 6 feet of the fire/smoke damper motor. The combination over current/disconnect means shall be either a little fuse #LSSY, for one Edison-base fuse and one single pole toggle switch sized.

g. A hallway fire/smoke door shall be closed only by the nearest smoke detector in alarm on either side of the fire/smoke door.

h. Heat detectors will only be allowed in mechanical rooms, and other areas that are not usually inhabited. Heat detectors shall be set at no less than 180 F. and have a rate of rise devise.

09. The following 4 bypass switches need to be programmed into the system:

a. Audio/Visual Bypass, Water flow bypass to include the fire pump points. Door holders, HVAV shutdown and Elevator bypass

switches. When the bypass switches are activated they will put a trouble in the system.

b. Tamper switches shall be programmed as non-latching.

c. Water flow switches shall be silenceable.

d. All addressable modules\relays shall be accessible at floor level or at a maximum height of 10 feet.

10. Special Systems CO/Freon gas alarms that require monitoring will tie directly to the DAC.

11. AHU 15,000cfm or larger require duct detectors on the supply and return sides of the unit. Building that is classified as lab space duct detectors shall shut down air handlers only when smoke is detected at duct detector. General alarm will not shut down these units.

12. All pull stations shall have keyed locks (Allen key type locks are not approved) for resetting purposes if available for installed system. Two keys for each pull station shall be supplied to Oregon State University.

13. Wiring for fire alarm systems shall be a minimum or ¾ inch trade size electrical metallic conduit. An exemption shall be made for a single run of conduit going to a single device and shall be ½ inch EMT. These conduit runs shall comply with the electrical section of the design criteria. Junction boxes shall be a minimum of a standard 4-inch square by one and one quarter-inch deep two-gang box. If a shielded or unshielded fire alarm cable is used in the conduit runs and junction boxes, a single cable shall be sized for conduit and box fill as a number 6 AWG THHN, single conductor cable as per NFPA 70. If single conductor wire is used, the size shall be specified by the fire alarm manufacturer or a minimum size of #16 THHN. The conduit and box fill can then be calculated on the wire gauge size of the actual conductor used.

14. At a minimum, provide on addressable loop per floor.

a. Each addressable loop shall have a minimum of three (3) isolation modules; two (2) at the FACP and one (1) midway through the loop address scheme.

b. For addressable systems, all devices shall match the brand of FACP installed and these devices shall be addressable analog devices.

All Door Holder circuits shall be 24 VOLT and powered by separate dedicated power supplies separate from power supply for Fire Alarm system). Power Supplies shall be a minimum of 4 Outputs. Each Output shall be individually fused.

15. All fire alarm system devices that are located on any exterior surface of the building shall be weatherproof as defined by the National Electric Code, article 100.
16. On major remodeling projects requiring additional fire protection beyond the capacity of the existing fire panel, the existing system shall be replaced by a new system control panel, i.e. NO add-on or patch panel(s) to existing fire system. An LCD annunciator shall be required at the "Fireman's entrance".
17. All devices for Fire alarm systems for additions or renovations shall be U.L. listed, matching existing devices or approved compatible devices for use with the existing fire alarm control.
18. ALL AUDIBLE SPEAKER NOTIFICATION APPLIANCE CIRCUITS shall be wired using stranded #18/2 or #14/2 conductor, shielded, with a drain wire, with conductor insulation colored white and black, RED PVC jacket, FPLP rated cable UL approved for use in fire alarm system wiring and approved by FMS (see manufacturers wiring requirements).
19. COMPLETE as-built drawings and riser diagrams with device addresses and installation documentation (including complete manual sets) of each device, shall be provided to Owner. A digital copy of the as-built drawings in AutoCAD shall be provided to Owner, and become property of the Owner.
20. Drawings to be black and white only, no color on both hardcopy and Auto CAD sets.
21. Warranty shall be for One Year and include 12 hour response time 24 Hours Per day including weekends and Holidays.
22. Materials, Architecture and Qualifying Vendors:
    a. Fire alarm systems shall be fully serviceable and programmable by the University.
    b. Contractor shall (prior to construction) submit shop drawings of the fire alarm system. Included shall be the contractor's prepared plan drawing showing devices, system riser, system interconnection drawings, and manufacturer's specification sheets. Drawings shall include design ambient sound level, audible alarm device sound power and alarm sound level for each space or contractor shall certify that design meets NFPA 72 for sound levels. Any additional devices required while verifying the system shall be at contractor's expense.

c. Fire Alarm Contractor shall specialize in fire alarm system installation, be factory trained and certified, and a minimum of five years documented experience installing and maintaining fire alarm system for similar installations.

d. The Fire Alarm Systems that meet requirements and are approved are:

1) Simplex 4100U, all others must be approved thru the OSU Alarm shop.

23. Contractor Submittal:

a. Contractor shall submit shop drawings and construction drawings of the fire alarm system. Included shall be the contractor's prepared plan drawing showing devices, system riser, system interconnection drawings, and manufacturer's specification sheets. Drawings shall include design ambient sound level, audible alarm device sound power and alarm sound level for each space or contractor shall certify that design meets NFPA 72 for sound levels. Any additional devices required while verifying the system shall be at contractor's expense.

b. The submittal package described hereinabove shall be submitted and reviewed by OSU Construction Management prior to construction and installation.

24. Documentation:

a. FACP contractor to provide (2) two copies of maintenance, repair manuals and (2) copies of software manuals required in operation, maintenance, repair, and modification (for system additions or deletions) of fire alarm system. Documentation provided shall be complete and include all necessary information to support the above stated functions. Manuals shall be bound, and published, consisting of the following:

1) Installation Manual
2) Operation/User's Manual
3) Technical Manual
4) Programming Manual

b. In addition the FACP Contractor to provide individual electronic PDF copies of all zone maps and local operating instructions. Permanent zone maps shall be provided for the FACP and all Annunciators, with an additional two (2) copies provided at the time of acceptance. The font size used on the zone maps shall

allow the room numbers and detector numbers to be clearly visible without magnification.

c. Documentation must be provided to the University at the time of acceptance.

25. Warranty and Preventive Maintenance Requirements:
    a. System shall have a 12 month warranty period for all installed or delivered hardware and software.
    b. All tests shall be scheduled by the Contractor through Facilities Alarm shop and will require fifteen (15) days notice. The test shall be witnessed by a representative designated by OSU Facilities alarm shop.
    c. A report consisting of the NFPA Inspection and Testing Form shall be furnished by the contractor, to the Engineer of Record and OSU Construction Management within 7 days after completion of this test. The NFPA Inspection and Testing Form can be found on page 72-I 11, of NFPA 72, latest edition.
26. Training Requirements:
    a. Training shall address all operational functions available to the system at the FACP including but not limited to any system variable changes, programming changes, report creations and changes, system functional changes, etc.
    b. Contractor shall also provide at no cost to the University, sixteen (16) hours of on-site owners training. Training to include hardware repair and maintenance by University personnel of all building panels, devices, including but not limited to diagnostic procedures, system expansion and maintenance techniques.
27. Labeling Requirements:
    a. Contractor shall label all wires terminating in junction boxes and riser boxes. These labels shall be self-sticking wire numbers or similar type. Write- on labels are prohibited. Contractor shall provide a typed legend for all junction boxes and riser boxes corresponding to these labels. Legend shall be mounted in riser boxes (if applicable). If system does not have riser boxes, contractor shall provide legend to OSU Alarm Shop at time of University acceptance of system installation.
    b. On conventional circuits (I.E. not addressable), <u>all initiating devices</u> shall be labeled with their respective zone and sequence number.

c. On intelligent addressable systems, all initiating devices and modules shall be labeled with their respective addresses to reflect all characters in order to Disable/Enable Device.

d. All device labels shall be made using an electronic labeling system with black letters on white background. Write-on labels are prohibited.

28. Programming and Software Requirements:

a. Contractor shall also include all software, hardware, interfaces, adapters, and cables, etc. required for all programming, and maintenance functions.

b. If the contractor would normally use a laptop to program the system, a similar computer shall be supplies even if programming from the FACP keypad is available.

c. Contractor shall provide to the University, all software required for full system maintenance and upgrades to fire alarm system including any device changes, additions, or deletions.

d. Contractor shall provide to the University, without cost**,** all software updates during the warranty period and free upgrades to software following the warranty period that address system operating failures or known defects during the life of the system.

e. Contractor shall provide to the University all levels of password access, and documentation to support the use of the above mentioned.

f. Contractor shall provide at no additional cost to the University, factory sponsored certified technical training for system installed. This training shall certify two (2) technicians to maintain, service, and program installed system and receive direct manufacturer's technical support for these systems, to include software updates if applicable. All expenses, to include tuition, transportation by University approved vendor and lodging for this training, shall be the responsibility of the contractor.

29. DACT Communication Requirements:

a. The fire alarm system (DACT) shall communicate in PID. All initiating circuits connected to the DAC must be normally open contacts.

b. Coordinate DACT programming and testing with OSU Facilities Alarm shop.

c. The DACT shall be mounted in an adjacent or nearest mechanical or electrical room to the FACP unless approved by the owner for installation adjacent to the FACP. OSU Telecom will install two dedicated phone lines for the fire alarm auto-dialer with a six-week lead time. No modifications or changes to existing or functioning fire alarm system will occur without two weeks written notification to our dispatcher at Cascade Hall ("central station")..

30. Security Requirements:
    a. Where applicable for addressable systems, a minimum of two levels of security are required at the FACP; one level for limited interrogation of system status and a second higher level for system programming changes.
31. Inclusion of Costs:
    a. Any costs for design, installation or programming required for any existing University FACP (if applicable) in order to add to the installation is to be included in contract.
32. Power and Environmental Recruitments:
    a. All system power to be isolated circuits with dedicated ground. (120 VAC 60 HZ) 32-122 DEG.F (OC-50C) *0-95%* RH (Relative Humidity), non-condensing.
33. Emergency Power Recruitments:
    a. Power for the FACP, DACT, printer and all remote power supplies shall be from the emergency power panel. Each shall be served by individual surge protected dedicated circuits.
34. Elevator Requirements:
    a. All fire alarm devices, separate zones and other requirements shall be included in the fire alarm system design for future connection to elevator capture. Only elevator recall smoke detectors in alarm shall close an adjacent elevator fire/smoke door. A smoke detector in one elevator lobby will not close any other fire smoke door. Elevator lobby smoke detectors shall accomplish elevator recall as specified by the elevator inspector.
35. Audible/Visual Signal Appliances
    a. All signal appliances, unless noted otherwise, shall be field selectable

ANSI S3.41 three-pulse temporal pattern. Unless noted otherwise, audible signal level shall be field adjustable, 101 dba high level and 96 dba low level. Sound level based upon anechoic dBA at 10 feet.

36. System Outages:
    a. The University desires to keep all life safety systems operating 100% of time. The contractor is to use all available means to avoid the need of disabling active fire alarm systems providing protection to buildings and/or people.
    b. The contractor shall notify the University prior to any work to contacts/interface with any alarm detection devices (smoke detectors, pull stations, horns, panels, etc.). If any disabling, disconnection, reconnection of fire alarm system equipment is necessary, the contractor shall notify the University at least five (4) working days prior to proposed work. Work cannot proceed until contractor receives written approval from the University.
    c. Disabling or disconnection shall be limited to one working day per occasion, and to shorter periods when possible. The Contractor shall be liable for any costs, direct or indirect, due to false alarms resulting from Contractor's work.
37. Air Handling Systems:
    a. All air handling units shall be shutdown directly by the FACP during alarm shutdowns. Fire alarm device relays and Building Automation Systems shall not be used for alarm shutdowns of air handling systems.
38. Use of RAILS on Conventional Hardwired Systems:
    a. Remote Alarm Indicator Light System (RAILS) for smoke detectors in non-occupied areas shall be used complying with applicable codes.
39. Roll down fire doors shall be equipped with electric motor up/motor down controls interfaced with the FACP. Powered Fire Curtains shall automatically be restored to the open position upon fire alarm system reset to normal. 1 NAC Power Supplies shall be addressable and wired Class B.
40. Spare Parts:
    a. The following spare parts shall be provided to OSU prior to final inspection of system:
        1) Fuses- (2) of each size used in the installed system.

2) MPS- w/ monitor modules - Minimum one or 2% of total installation.
3) Audio-visual devices- - Minimum one or 4% of total installation.
4) Indoor strobe only devices - Minimum one or 4 % of total installation.
5) Exterior indicating devices-- Minimum 1 or 2% of total installation.
6) Spot Smoke Detectors- - Minimum one or 6% of total installation.
7) Spot heat/thermal detectors- - Minimum one or 6% of total installation.
8) Spot detector bases-- Minimum one or 2% of total installation.
9) Spot detector sounder bases- - Minimum one or 6% of total installation.
10) Relay modules- Minimum one or 4% of each total installation.
11) Monitor modules-- Minimum one or 4% of total installation.
12) Isolation modules- - Minimum one or 4% of total installation.

Section 31 00 00 – EARTHWORK

PART 1 GENERAL

1. REQUIREMENTS
   A. For all earthwork, the designer shall include provisions for utilizing geotextile fabric, and overexcavation for times when conditions warrant.
   B. All aggregate baserock, asphalt, and other materials are to be specified in accordance with the latest version of the "City of Corvallis Standard Construction Specifications".
   C. Pea gravel is not permitted as bedding or fill material.
   D. All baserock under asphalt and concrete paving sections should be ¾"-0" per ODOT standards, and specified for compaction to a minimum 95% of ASTM D1557.
   E. All layers of baserock shall be compacted at a maximum depth of 12-inches.
   F. The designer needs to include provisions in the specifications requiring the Contractor to coordinate for special testing, including compaction tests, asphalt placement, and concrete placement.

2. EROSION CONTROL
   A. Erosion control shall be installed in accordance with the City of Corvallis Land Development Code, and be approved by the OSU Project Manager prior to the commencement of any grading.
   B. All erosion control information shall be clearly indicated on plans and specifications and designed in a manner consistent with all applicable code requirements.
   C. Sediment and erosion control barriers within tree protection areas shall not be installed below the existing soil surface utilizing trenching or other excavation methods that will adversely affect tree root zones. Sediment fencing shall be anchored utilizing surface weighted fiber filled mesh filtration bags or similar approved system.
   D. The Contractor is responsible to apply and obtain an erosion control permit from the City of Corvallis prior to commencing any grading activities on the project site. The City approved permit shall be obtained from the City of Corvallis and provided to the OSU Project Manager prior to the beginning of construction.
   E. The designer/engineer/architect is responsible to determine if a NPDES 1200 – C permit is required for the project. Permit application to be coordinated by Project manager.
   F. All erosion control measures required for a NPDES 1200 – C permit shall be indicated on an *Erosion Control Measures* drawing which is to be prepared by the designer/engineer/architect, and included in the plan set.

G. The designer/engineer/architect shall coordinate the preparation of the Erosion Control Measures drawing with the OSU Project manager.

H. The DEQ NPDES 1200-C permit shall be obtained prior to commencing any grading activities on the project site.

I. Termination of the NPDES 1200-C permit will be the responsibility of Project Manager

3. GRADING

A. The contractor is responsible to apply for and receive a grading permit from the City of Corvallis, and submit a copy to the OSU Project Manager prior to the commencement of any grading on the site.

4. Tree Protection

A. The designer needs to show tree protection fencing per City of Corvallis requirements, with direction to the contractor for implementation.

Section 32 10 00 – PAVING

PART 1 – GENERAL

1. REQUIREMENTS
   A. Asphaltic Paving Sections
      01. The use of permeable paving should be considered as appropriate to meet OSU sustainability initiatives.
      02. Multi-use paths require a minimum of 4-inches of Class "C" asphalt (2-2 inch lifts) over 6-inches of ¾"-0" baserock and subgrade geotextile.
      03. The design should try to match existing grade, in order to minimize elevation differences at the edges.
      04. Compaction of exposed edges should be called out on design.
      05. Non-thoroughfare paving sections (i.e., parking lots) accessible to cars require 4-inches of Class "C" asphalt (2-2 inch lifts) over 12-inches of ¾"-0" baserock.
      06. Streets, alleys, and access ways for trucks and buses, including thoroughfares through parking lots require, at minimum 4-inches of Class "C" asphalt (2-2 inch lifts) over 18-inches of ¾"-0" baserock.
   B. PCC Paving Sections
      01. All Portland cement concrete (PCC) paving and slab sections are required to have 6-inches of ¾"-0" baserock and 6-inches of 4,000 psi concrete, as a minimum.
      02. If vehicles have any possibility of access to the paving section, then reinforcing bars (ASTM A615, Grade 60) should be specified.
      03. If vehicles do not have the possibility of access to the section, then wire fabric conforming to ASTM A185 may be used.
      04. If wire fabric is allowed, proper specifications are required to ensure it is placed properly during concrete placement, and not left in contact with the ground.
      05. Portland Cement Concrete (PCC) paving sections for main thoroughfares, including heavy trucks, buses, and heavy equipment require a minimum of 8-inches of ¾"-0" baserock and 8-inches of 4,000 psi concrete.
      06. All concrete sections designed for vehicular traffic, requires reinforcing steel, and a 2-inch thicker concrete section within 12-inches of all edges.
   C. Sidewalks, wheelchair ramps, driveways
      01. All sidewalks, wheelchair ramps, and driveways shall be designed per latest City of Corvallis Standard Construction Specifications and associated detail drawings, with the following exceptions:
         a. Minimum depth of baserock shall be 4-inches, rather than 2-inches.
         b. All concrete shall have a minimum strength of 4,000 psi.

c. All sections of sidewalk to be used for vehicular parking, maintenance, and/or construction access, are required to be a minimum of 6-inches thick and reinforced per "PCC PAVING SECTIONS" in this Design Criteria.

d. The maximum percent of cross slope used for sidewalks is less than 2%. The designer shall specify 1.5%, and include a specification or general note that states any walkways with cross slopes exceeding 2% shall be removed and replaced by the contractor at his cost.

e. When a cross slope for a ramp is used, it shall comply with (d).

f. Avoid using cross slopes on landings, unless required for drainage, then use a slope of less than 1%.

g. The preferred run slopes for exterior ADA ramps serving buildings is less than 1:20. If the preferred slope cannot be achieved because of site or technical restrictions, than a slope of 1:20 to 1:16 should be used. These percent slopes are considered an OSU best practice for providing access to the buildings and programs on campus.

h. Architects and engineers shall use this OSU practice as initial design standard when designing ADA ramps for building entries.

i. When the use of the best practice standard is not technically feasible, then the most practical percent slope shall be used.

j. Any diversion from this best practice will need to be communicated and coordinated with the Office of Affirmative Action prior to a decision not to use the best practice standard.

k. Refer to Section 01200, Part 2, Subsection 6, OSU Americans with Disabilities Best Practices for additional standards.

D. Parking Lots

01. Parking lot designs shall be based on this document: "City of Corvallis Design Criteria, and City of Corvallis "Off-Street Parking and Access Standards", latest version. The Consultant and/or Contractor are responsible for obtaining a copy of the document from the City of Corvallis.

Section 32 80 00- IRRIGATION

PART 1 - GENERAL

1. REQUIREMENTS
   - A. An automated underground irrigation system shall be designed and installed for all planted areas.
   - B. All irrigation systems shall be institutional quality and be centrally controlled using components compatible with Rainbird Maxicom.
   - C. 4” min PVC Sleeves are required under all hard surfaces, to enclose all mainlines laterals, and control wires. Sleeves shall extend one foot beyond edge of pavement to link all planting areas.
   - D. Separate irrigation metering connected directly to city service line shall be provided.
   - E. Deduct metering on the domestic service line is prohibited.
   - F. Design velocity shall not exceed 5 feet per second.
   - G. All irrigation systems shall be designed according to Irrigation Association current standards.
   - H. Ensure as built markup documents are completed by the installation contractor and reviewed/confirmed by landscape architect before piping is buried.
   - I. A water audit performed by an Irrigation Association IA) Certified Landscape Irrigation Auditor, conducted in accordance with the current IA audit standards for all new, as well as existing, irrigated zones shall be completed. An audit report shall be approved by the OSU Landscape Manager or designee.
     - 01. The report must provide complete database information for programming of Maxicom 2 Central Control System per Section 1.3

2. IRRIGATION EQUIPMENT
   - A. Irrigation Heads
     - 01. Spray heads
       - a. Rainbird, 1800 PRS series, Hunter PRS 40 MP Rotator,
       - b. Mid size, gear drive, Hunter I-20 SS low angle and short radius, Rainbird 5000.
       - c. Large turf areas, Hunter I-20 SS or I-25 SS Series stainless steel.
         - 1. All spray heads installed with flex pipe, rotors installed with PVC swing joint assemblies
     - 02. Drip systems shall be installed only where institutional spray systems are impractical, due to design constraints or other factors as approved by OSU Landscape management.
       - a. When used, they must be Rainbird brand dripline with automated stainless steel filtration system.
   - B. Electric Control Valve
     - 01. Type: Rainbird PEB/PRS series.

02. Zone Isolation valve: unionized brass angle globe valve.
03. All control valves shall have isolation valves and downstream unions.
04. Sub main isolation valve: brass resilient seat gate valve

C. Pipe
01. Schedule 40 PVC only.
02. Mainline depth 18"-24".
03. Lateral depths 12"-18".
04. Control valve depth 12”
05. No gasketted pipe or compression couplings are permitted
06. Provide supplemental air to minimum 125PSI pressure test to ensure no loss of pressure in 4 hour test period

D. Control Wire
01. Copper UF 14 AWG minimum.
02. A unique pair of spare wires shall be installed from the controller to each valve.
03. Unique spare control wire to each valve, BLACK.
04. Spare common wire shall be installed from the controller and looped at each valve, YELLOW.
05. Locate wire, UF 16 AWG. minimum, spliced with waterproof connectors-BLUE.
06. Control wires to be spliced with waterproof connectors only in valve boxes. No directly buried splices are allowed.
07. Master valve shall have independent circuit
08. Provide ohm readings verifying continuity of all control wires, including spares.
09. Provide waterproof circuit numbers at termination of all control wires, including spares. 3M ScotchCode Wire Marker Tape wrapped at least 3 revolutions around each wire.

E. Valve Boxes
01. Pentek or Carson of suitable size. (T-top lids green in turf and brown in shrubs).

F. Backflow Preventer
01. FEBCO 805Y 850-U with ball valves and unions for easy removal and service in underground valve box

G. Central Control Components
01. All systems must be compatible with Rainbird Maxicom and must include flow sensing, receiver card remote control, and master valve controls.
02. All irrigation control assemblies shall be UL listed.
03. Pedestal control cabinet bases shall be cast in place concrete per PCC requirements. Pre-cast bases must be installed per manufacturer’s specifications.

H. Controllers
01. Rainbird, ESP-SAT.

3. IRRIGATION COMMISSIONING
   A. All irrigated landscape areas shall:
      01. Have a Landscape Irrigation Audit performed by a certified Landscape Irrigation Auditor, certified and in good standing with the Irrigation Association (IA).
      02. The auditor shall be retained by the University and shall be independent of all contractors associated with the project.
      03. The audits shall be conducted in accordance with the current edition of the IA's Landscape Irrigation Auditor's Handbook.
      04. The results of the audit shall be provided to the University in a report acceptable to the University and shall be signed by the Auditor.
      05. All existing adjacent irrigated landscape zones impacted by construction activities shall be included in the irrigation audit.
      06. A completed audit in compliance with these provisions is required before the University will issue a Letter of Substantial Completion.
   B. The minimum efficiency requirements to be met in the audit are 55% distribution uniformity for all fixed spray systems and 70 % distribution uniformity for all rotary systems.
      01. All zones not meeting these minimums shall be corrected by the irrigation installer and retested to meet these specifications. Compliance with this provision is required before OSU shall accept the audit report.
   C. Pre audit equipment review shall note any installation errors, necessary repairs, performance deficiencies and problems, etc., The review shall also include verification of the installation and operation of all Maxicom equipment, flow sensors, master valve, telecommunication paths, connectivity to the central computer, etc. Any deficiencies shall be corrected by the installer before the commissioning audit shall begin.
   D. The auditor shall be responsible for collecting the following information:
      01. The data necessary to calculate precipitation rates (zone areas, flow rates), note and record soil types, root depths, sun exposure, slope and plant material characteristics for each zone.
      02. Perform catchcan tests of each zone and mark corresponding catchcan location on the as built irrigation drawing. Shrubs zones precipitation catchcan measurements are to be taken before planting.
      03. Measure flow rates, static and dynamic system pressures, and record catchcan quantities and locations for each zone.
   E. The audit report shall include:
      01. The marked up drawing of the system design showing as built conditions.
      02. The drawing shall show the station numbers, station locations, sprinkler head locations, head types, nozzle size, and distance between sprinkler heads.

03. This as built drawing at 1:10 or larger scale shall be provided to the auditor by the installation contractor prior to field precipitation measurements being collected.
04. Installer shall also provide imported soil texture analysis reports and locations and depth of soil placed in each zone.
05. Pressure readings per station, catch device readings and locations, distribution uniformity for individual stations, precipitation rates per station, and full database information for programming Maxicom II ET based central control software.
06. Include a Maxicom data summary spreadsheet for client input including, Maxicom Flo-Manager and Flo-Watch zones for proper scheduling.

Section 32 90 00 – PLANTING

PART 1 – GENERAL

The historic campus core of Oregon State University is known as one of the most significant public landscapes in the State. Its organization, harmony of materials, and maturity give it a sense of substantial quality. Maintaining this quality takes consistency in approach and sensitivity to what makes the campus great.

The University's core campus is based on a plan created in 1909 by the renowned Olmsted Brothers of Boston, whose designs include Central Park in New York and Stanford University. Their plan for the University provides a classic elegance that befits and encourages the academic activities occurring at Oregon State.

Campus streets provide the organizational framework within which the campus has developed. In addition to accommodating vehicular, pedestrian and bicycle circulation, they provide tree lined open space corridors through campus.

The form and organization of campus buildings, established by the 1909 Olmsted plan, provides a dignified simplicity which is integral to the character of the campus. Buildings reinforce the open space corridors and quadrangles through uniform setbacks and sufficient spacing between structures. Primary outdoor gathering places in the form of courts, plazas, and gardens are located near building entries.

The quadrangles provide the primary usable open space on campus. These large open lawn areas are defined by buildings and provide distinction to the campus. The quadrangles are strictly pedestrian oriented with walkways interconnecting building entries, linking to the campus street grid and connecting to other campus open spaces.

The current Campus Master Plan reestablishes the integrity of the Olmsted plan. It calls for further development of the University based on the organization of the historic campus core. The campus core is envisioned to expand to the west and south over the next several decades. In order to ensure that the campus becomes cohesive in character, each increment of growth should embody the qualities of the existing core. This approach requires consistency in the development of buildings and grounds and sensitivity to the scale and character of outdoor space.

To ensure that Oregon State University maintains and expands upon the historic patterns, it is critical that development provides consistency and a common approach, regardless of the scale of a campus improvement. This document provides guidelines which are critical to the continuation of the quality of the campus. It is intended to provide the basis for evaluation of

all campus improvements and should be used as a tool to ensure that campus development be of the highest quality.

1. UTILITY LOCATION
   - A. Above-grade utilities, i.e. power transformers, A.C. units, should be located away from primary building entries, important building facades and pedestrian routes.
   - B. Above-grade utilities should not occur within primary street corridors.
   - C. Utilities should be accessible to maintenance personnel.
   - D. At grade vaults should be located within paved surface areas, traffic rated, and set flush with adjacent grades and slopes.
   - E. Above-grade utilities should be screened from public view.
   - F. Utility conduits and wiring should be underground and routed to provide adequate space for tree lined streets and open space corridors

2. SERVICE AREAS AND ABOVE GRADE UTILITIES AND EQUIPMENT
   - A. All service areas and utilities should be permanently screened from view as feasible.
   - B. Screening materials should be similar to those used on or near adjacent buildings.
   - C. Vegetative screening, when used, should provide visual screening year round.
   - D. The choice of screening materials and their placement should be in consideration of personal safety of campus users.
   - E. Screening materials may include combinations of the following:
   - F. Masonry
   - G. Iron fencing
   - H. Plant material
   - I. The use of barbwire, chain link, chain link with slats is not allowed except within agricultural areas or around substations.

PART 2 - CAMPUS CIRCULATION

Development of the Campus should reinforce the existing grid pattern of streets and walks as primary circulation.

The historic pattern of streets with defined edges, continuous street tree planting and walkways separate from the street should be maintained throughout campus.

OSU should continue to be a pedestrian dominant campus with continuous and convenient pedestrian access throughout the campus. Safe and convenient bicycle access should be provided on multi-modal paths, campus streets and other bikeways.

1. STREETS
   - A. Streets should adhere to the existing rectilinear street grid.
   - B. Pavement types, street configurations and street tree placement should be consistent throughout street corridors.

C. Streets should be continuous and not bridged or encroached upon by buildings or other facilities. Building setbacks should be uniform along campus streets.

2. WALKWAYS

A. Walkways should be located on both sides of all campus streets.

01. Walkways should interconnect campus quadrangles and provide access to all campus facilities.

02. Walkways should provide direct routes to campus facilities. Walks should be simply detailed, rectilinear in nature, and sized to accommodate the volume of pedestrians using them.

03. Walkways shall meet Americans with Disabilities Act requirements.

04. Walkways should be a minimum of five feet in width except in specialty areas.

05. Tree lawn areas, those areas between the edge of the street and the sidewalk, should be a minimum of ten feet in width and planted in lawn or low shrubs to ensure visibility and personal safety.

3. BIKEWAYS AND PARKING

A. OSU recognizes the importance of bicycle transportation on campus as a vital strategy to reduce automobile traffic, parking demand and use of single occupancy vehicles. As such, needs unique to bicycle transportation infrastructure must be considered during campus development much the same way specific motor vehicle and pedestrian infrastructure needs are considered.

01. Bikeways should be located primarily on campus streets, multimodal paths and other designated areas.

02. Bikeways should be designated in a routing plan and minimize conflicts between pedestrians and bicyclists.

03. Bicycle parking should be conveniently located adjacent to bikeways and not within the quadrangle areas, but rather on quad perimeters.

04. Bicycle parking should be located in well lit, highly visible and secure locations within 50 ft of a main entrance to a building, but not further from the entrance than the closest automobile parking space, but in no case further than 50 ft from an entrance where several entrances are involved. When there are multiple entrances to a building that are highly used, consider placing racks at all such locations.

05. Bicycle parking spaces should be at least 6 ft long and overhead clearance in covered spaces should be at least 7 ft and no higher than the ceiling height of the first story. Racks shall be mounted no closer than 2 feet from the nearest wall.

06. A 5 ft aisle for bicycle maneuvering should be provided and maintained beside or between each row of bicycle parking.

07. Bicycle racks or lockers should be securely anchored to the surface or a structure.

08. Covered bike parking shall be constructed per the design provided in the Approved Site Furnishings List. Alternatively, bike parking covers that match the architectural design of the associated building may be used.
09. Curb cuts should be provided near the rack location to discourage users from riding the sidewalk to access the racks.
10. In cases where bicycle parking spaces are not visible from the primary building entrance, signage shall be used to direct cyclists to bicycle parking areas.
11. In cases where neither the Construction Standards nor City code addresses a situation, the Oregon Bicycle Plan shall be used to provide guidance for design and construction of bicycle facilities.

4. ACCESSIBLE ROUTES INTEGRATION
   A. Accessible routes should be constructed from the same paving material and detail as other building entry pavements.
      01. Ramps should be integrated into the campus through the use of masonry walls and plant material screening where appropriate.
      02. Accessible routes which are added to existing buildings should appear to be integral to the building entry.
      03. Where possible, primary routes should provide single routes for all users, instead of segregating accessible portions.
      04. Accessible routes should be constructed from the same paving material and detail as other building entry pavements.
      05. Ramps should be integrated into the campus through the use of masonry walls and plant material screening where appropriate.
      06. Accessible routes which are added to existing buildings should appear to be integral to the building entry.
      07. Where possible, primary routes should provide single routes for all users, instead of segregating accessible portions.
      08. Signs denoting accessible routes should be clear, concise appropriately sized, and consistent with the campus sign policy.

PART 3 - PLANTING

The campus landscape should adhere to the tenets of the 1909 Olmsted Plan, in order to maximize the plants' visual qualities and reinforce the campus organization and function. Plant material selection, placement and maintenance should focus on their appropriateness to the adjacent land use as well as the materials' ability to reinforce the campus character.

1. ORGANIZATION
   A. The historic Olmsted pattern of planting should be reestablished and adapted to support current building uses and site requirements. As the campus core expands, planting should be of similar character to that of the historic core.

B. Large deciduous trees planted in continuous and uniform rows (allees) should line campus streets.
C. Primary open spaces such as quadrangles should be planted in open lawn framed and highlighted with large coniferous and deciduous trees.
D. Plantings at building foundations should ideally respond directly to the adjacent architecture. Shrubs should not be taller than the building's visual base, or obscure the views from primary windows and entries. Shrub beds adjacent to the building should generally have widths approximately 20% of the building's height.

2. SPATIAL DEFINITION
A. Plants should be used to define building entries, create outdoor space and assist in focusing pedestrian circulation.
B. Plants alone will not deter pedestrian desire lines or provide significant barriers to circulation. Therefore, plants should be used in conjunction with good site design, effective circulation systems and other elements such as masonry walls.

3. SCREENING
A. Plants may be used to visually screen undesirable views, such as service areas, waste and recycling stations, and above grade utilities.
B. Plants used for screening should be selected based the ability to provide year-round screening, the material’s ultimate size and requirements for healthy growth without sheering or excessive pruning.
C. Plants should provide the desired height and density taking into consideration circulation requirements, safety, the needs of the use being screened, ingress and egress requirements as well as aesthetics.
D. In many cases, plant materials used in conjunction with constructed screening devices such as masonry walls provide the most appropriate and functional solution.

4. PLANTING
A. Landscape design and components shall be planned for low ongoing maintenance requirements and reduced life cycle costs.
01. Design and plant selection shall support species and varieties that are appropriate for the climate and growing conditions particular to the region in which the OSU campus is located.
a. Prior to the start of the project, the OSU Landscape Shop shall submit a *non- approved plant list* to the Project Manager.
b. Any plant species or variety indicated on the *non-approved plant list* shall not be used.
02. The landscape plan and plant species shall be approved by the OSU Landscape Manager or designee prior to the acceptance of the landscape plan.

a. Any changes to the plan as a result of the review of the OSU Landscape Manager shall be completed prior to the issuance of the approval from the OSU Landscape Manger, or designee.

03. The landscape design must accommodate the mature size of the plants selected. Draft planting plans utilizing plant symbols which represent the mature size of the plant material. Coordinate tree replacements with Electrical Designer to avoid conflicts with exterior light poles.

04. The contractor shall protect existing topsoil and subsoil from compaction during construction.
   a. The contractor is responsible for alleviating any and all unavoidable soil compaction before topsoil placement or irrigation system installation.
   b. Any mulch or base rock installed as part of the construction process or used to prevent soil compaction shall be removed from planting areas and turf areas prior to the placement of top soil.

05. Provide landscape specifications which conform with the International Society of Arboriculture development guidelines for soil preparation and planting

B. Plants

01. All shrubs and trees must be labeled with original nursery I.D. tag and shall be true to form and description.

02. Provide inspection point for landscape architect / landscape management representative/ OAR to select /approve trees:
   a. at nursery prior to digging
   b. at arrival at project site.
   c. Plant layout and installation

03. Prohibited plants include all Oregon Department of Agriculture and United States Department of Agriculture listed noxious plants as well as plants on the OSU *non-approved plant list. See list of OSU non-approved plant list at end of this standard.*

04. Plants shall be grouped with like water requirements on same irrigation zone.

05. The minimum size for trees is 2” caliper.
   a. Exceptions may be granted by the OSU Landscape Manager or designee for unusual species.
   b. All trees smaller than 2” must be triple staked.

C. Turf

01. The minimum mowing equipment width is 60”. Turf areas must be designed to be maintained with this equipment.

02. Seed shall be Champion Perennial Rye grass.

03. Champion Perennial Rye may be substituted upon approval from the OSU Landscape Manager or designee.

04. The allowable grass seeding period for OSU campus is March 15th through October 15th, as soil conditions permit.
05. A ten- inch wide concrete mow band shall be installed at finish grade adjacent to all structures. And 20” minimum beneath all fences.
06. No plastic or metal edging shall be permitted or used.

D. Soil

01. The OSU Landscape manager or designee shall determine if any existing top soil is suitable for reuse prior to the preparation of the landscape plan.
    a. The designer shall contact the OSU Project Manager to receive approval to utilize the exiting top soil in the landscape plan.
    b. All existing top soil approved for reuse shall be used to the greatest extent practicable.
    c. The allowable landscape construction period for OSU campus is March 15th through October 15th, as soil conditions permit.
02. Separate top soil (maximum 18” depth) from subsoil during excavation and protect from contamination.
03. Imported soil is subject to OSU approval and shall conform to USDA soil texture class, “loam” certified within one calendar year.
    a. Imported soil depth minimum when placed on subsoil
        1) 12" for turf areas with no trees.
        2) 24" for shrubs and turf areas containing trees.
        3) 36” when placed over rock or fill materials
        4) Tree planter pits shall have sufficient soil volume to support mature tree root space as calculated per ISA standards.
        5) Scarify subsoil and blend subsoil with first lift of imported soil. Install soil in 6” compacted lifts not to exceed 85%.
    b. The contractor shall provide OSU a test sample for textural class determination prior to the installation any imported soil.
        1) The test shall be performed utilizing wet sieve soil texture analysis by OSU Central Analytical Lab or other OSU approved lab.
        2) Provide a minimum of two soil samples with the accompanying soil test report from samples obtained randomly throughout the source field location or stockpile.
        3) Submit approved test results at least 4 weeks prior to soil placement
04. Athletic play areas may include USDA soil texture class sandy loam.
05. Soil must be free of contaminants and noxious weeds.

a. If noxious weeds are present, contractor shall eradicate following guidelines in PNW weed control handbook or Oregon Department of Agriculture recommendations and shall continue monthly control measures on all emerging weeks for a period of one year from final acceptance.

06. Incorporate organic matter homogeneously throughout the planting area.

07. Remove all rock from planting areas prior to topsoil placement. No loose rock is permitted for drainage or decorative elements.

08. Provide Landscape Architect's inspection point for :
    a. subsoil preparation
    b. irrigation installation and as-built mark-ups before covering with soil
    c. topsoil / amendment incorporation and finish grades

5. PLANT SELECTION

A. Plant materials should remain appropriate in their location as they mature and reach ultimate size.

B. Continuous plantings of large street trees should remain a primary method of linking the campus together. Tree types and spacing should be consistent within large defined areas. Breaks in species should occur in significant intersections only.

C. Groundcovers, flowering trees and deciduous and evergreen shrubs should be used primarily at the base of buildings to provide seasonal color and variation, reinforce the building's architectural style and soften the building's bulk and mass.

D. When adjacent to buildings, trees should be chosen and located to allow sun penetration during the winter and shading during the summer.

E. Specialty plantings, including perennials, should occur primarily in courts and special gardens. Plants should be selected based on the University's ability to maintain them.

Section 33 00 00 – UTILITIES

PART 1 - GENERAL

1. REQUIREMENTS
   - A. A utility locate of the areas within the proposed construction zone shall occur prior to any excavation or mobilization of project.
   - B. The OSU Project Manager shall coordinate the utility locate, and all correspondences associated with the completion of the utility locate shall be provided to the project manager.
   - C. All underground utilities shall be designed and constructed per City of Corvallis "Design Criteria" and "Standard Construction Specifications", respectively.
     - 01. Capacities, slopes, and other design considerations for gravity flow lines require the most conservative design, unless otherwise approved in writing by the University Civil Engineer.
     - 02. Minimum allowable depth of cover for all utilities is 36-inches, unless other design provisions are implemented, and approved by the University Civil Engineer.
     - 03. Stormwater detention and water quality systems shall be based on City of Corvallis criteria, and require approval of the University Civil Engineer.
     - 04. Volume capacity for detention basins, should be calculated based on saturated ground water conditions.
     - 05. All detention systems should be designed to minimize maintenance, and provide adequate access for cleaning and maintenance activities.
   - D. All projects connecting to existing gravity flow utilities shall include provisions requiring the Contractor to video all new piping outside the building, to one manhole downstream from the new connection.
     - 01. If the project ties into an existing manhole, or replaces a manhole, then the camera work needs to include the piping to the next manhole downstream.
     - 02. The video is to be submitted to the University Civil Engineer upon completion.

2. FRANCHISE UTILITIES
   - A. All franchise utility underground work requires coordination, review, and approval of the University Civil Engineer.
     - 01. All work shall conform, at a minimum to all jurisdictional codes and regulations. Minimum depth of cover for all utilities is 36-inches, unless otherwise approved by the University Civil Engineer.
   - B. Chapter 2 of the Campus Master Plan recommends utility distribution lines be underground, and OSU's preference is to locate all new utilities underground. If existing above ground utilities are within the project limits, then provisions

should be implemented by the designer to have the utilities relocated underground unless otherwise approved by the Director.

01. If the utility is owned by a franchise, with a recorded easement, then the cost of relocation would be the responsibility of the project. If an easement does not exist, then the cost would be the utility's responsibility, and a new easement would need to be coordinated through the University Civil Engineer.

Section 33 09 00 – METERS

PART 1 - METERING

1. GENERAL REQUIREMENTS
   - A. All buildings shall be fully metered for electricity, steam, condensate, potable and irrigation water, sewer deductions, natural gas, chilled and heating water, and other utilities where applicable.
   - B. The installation of any utility-owned equipment shall be completed in accordance with the utility requirements of the supplier of the utility (i.e., Pacific Power, NW Natural Gas, etc).
   - C. Utility meters shall be integrated with the Building Management systems to allow for monitoring, trending and preservation of records for all utilities.
   - D. Meters shall be positioned in a way that they are easily readable
   - E. Meters shall remain powered and operable during construction projects, unless prior permission is granted by the Project Manager and Utility Data Manager

PART 2 – METER SPECIFICATIONS

2. REQUIREMENTS
   - A. Electricity meters: Landis and Gryr E650 S4e with RS-485 and 480 volt power supply, if required.
   - B. Steam meters: Foxboro Vortex 84F (flanged) flow meters equipped with either digital remote transmitter or KEP Intellect-69 remote totalizer. Communication signal to be digital 4-20mA.
     - 01. Steam meter shall be sized for estimated maximum steam flow, not pipe size
     - 02. Meter installation requirements, such as lengths of unobstructed pipe, meter head position, etc. must be followed
   - C. Condensate meters: Foxboro magnetic flow MAG2RT with remote-mounted transmitter. Communication signal to be digital 4-20mA.
     - 01. Meter installation requirements, such as lengths of unobstructed pipe, meter head position, flooded pipe condition, etc. must be followed
   - D. Water meters: Sensus meter, to meet City of Corvallis requirements. 1” pipe and smaller are to be SRII; 1.5” pipe and larger are to be OMNI-type meters. Meter transmitter unit (MXU) shall be Sensus model 520-R, TouchCoupler-enabled to integrate with City radio-read system.”
     - 01. Meters to be placed on all incoming domestic and fire mains.
   - E. Sewer deduction meters: Sensus meters, to meet City of Corvallis requirements. 1”pipe and smaller are to be SRII; 1.5” and larger are to be OMNI-type meters. Meter transmitter unit (MXU) shall be Sensus model 520-R, TouchCoupler-enabled to integrate with City radio-read system.”

01. Sewer deduction meters to be placed on lines dedicated to equipment that does not send water to drain. This includes, but is not limited to, cooling towers and irrigation systems.

F. Natural gas meters: To be provided by the natural gas utility, currently Northwest Natural.

Section 33 63 00 – STEAM DISTRIBUTION SYSTEMS

PART 1 – GENERAL

1. REQUIREMENTS
   - A. The campus steam system operates at 60 psi saturated.
   - B. Provide condensate pumps at each building.
   - C. All systems components of the steam and condensate systems are to be rated to operate at a minimum of 150 PSI and meet all ANSI and ASME Codes and standards.

2. PIPING
   - A. Design steam lines using schedule 40 black steel pipe.
   - B. Fittings can be either welded, raised flanged, or threaded - depending on the pipe size.
   - C. Design condensate return lines using schedule 80 black steel pipe.
   - D. Fittings can be either welded, raised flanged, or threaded depending on pipe size.
   - E. Include provision for expansion and contraction of steam and condensate lines to prevent noise.
   - F. All piping delivering steam or condensate must be properly insulated according to the application.

3. TRAPS
   - A. Armstrong is the preferred brand traps.
   - B. The following factors must be considered when sizing and typing steam traps:
     - 01. LOAD: The amount of condensate the trap must handle.
     - 02. APPLICATION: How the trap is used.
     - 03. SUPPLY: Modulated or constant supply.
     - 04. BACK PRESSURE: The pressure (or range of pressures) at the trap outlet.
     - 05. SUPPLY PRESSURE: The pressure (or range of pressures) at the trap inlet.
   - C. When appropriate, expand capacity ratings to avoid using a larger, less efficient trap.
   - D. In selecting traps, the maximum differential pressure can be used in the sizing calculation as long as the operating differential is at least 80% of the maximum differential. If the operating differential is less than 80% of the maximum differential, ensure the trap will provide adequate drainage at both the maximum differential and the operating differential.
   - E. In applications where the operating differential has a range, the trap must be able to drain the calculated load at the minimum operating differential as well.

4. VALVES
   A. Select all valves and apurtenances at 1-½ x working pressure with 150 PSI minimum.
   B. Flanged valves must have a raised face and be provided with a Flexitallic gasket with cast steel bodies.
   C. Specify rising stem gate valves for all steam and condensate systems.
   D. Safety relief valves must be located and vented to prevent injury to personnel.
   E. Design in adequate maintenance access to all valves.
   F. Spence PRV's are preferred.
   G. Thermostatic controlled vales (such as Danfoss) shall be used in any place where convectors are installed (hot water or steam), or DDC modulating valves.

5. DIRECT BURIED STEAM PIPING
   A. Direct buried piping for steam and condensate piping to have metallic carrier pipe, insulation, one inch air space, and a metallic outer conduit with fusion bonded epoxy coating. *Product based on Rovanco Hi-Temp Conduit for below ground applications or Perma – Pipe ESCON-A ®FERRO-SHIELD®. Provide cathodic protection for direct buried steam and condensate piping systems.
   B. Expansion Joints:
      01. Bellows type with stainless steel bellows.
      02. 150 psi working pressure.
      03. Preferred manufacturer – Hyspan.
      04. The mechanical engineer is responsible for the design and coordination of the steam and condensate supports and anchoring system.

6. VAULTS
   A. Provide vaults in the direct buried steam system where there are devices that need maintenance.
   B. Size vaults for adequate access for installation, maintenance, operation, and removal of components.
   C. Include a sump pump and a ladder and a drain.
   D. Provide waterproof coating on exterior of vaults.

7. METERING
   A. All buildings shall be metered for both steam and condensate.
   B. Steam and condensate meter equipment, installation and application details are specified in Section 33050 – Meters.