The Pennsylvania State University
OFFICE OF PHYSICAL PLANT

DESIGN STANDARDS
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All sections are November 2008 version unless noted in the “Rev. Date” Column

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INTRODUCTION

This manual of Design and Construction Standards has been prepared by the University to guide Architects and Engineers, hereinafter referred to as the Professional, commissioned to design buildings and other facilities for The Pennsylvania State University. The information contained herein applies to the University Park Campus; the Commonwealth College Campuses; Penn State Erie, The Behrend College; Capital College; The Milton S. Hershey Medical Center; and all other locations.

These standards and guidelines are the result of considerable experience in the design, construction, operation and maintenance of a substantial number of physical facilities. It is intended that the material included in this manual shall be applied in the preparation of documents for the design and construction of new buildings and renovations to existing physical facilities. If the Professional believes that a specific situation requires a deviation from the standards contained in this manual, he should discuss such a deviation with the University Project Manager, and request in writing that a special exception be approved.

All buildings and other projects for the University shall be designed as quality institutional facilities with components specified to provide maximum life-cycle usefulness. The University establishes the total project budget, including the maximum fund available for construction. The Professional is charged to monitor program requirements and cost estimates to assure that the project is designed within available funding, and that it does not deviate from the quality standards established in this manual.

The Professional shall design the project in compliance with all applicable Federal, State and Local codes, ordinances, laws and other regulations which have jurisdiction over the nature of the construction. If any of the above are at variance with the material in this manual, the most demanding requirements shall be observed.

In addition to the above mentioned codes, for University owned buildings, the University uses the most current editions of the following codes and standards as design criteria:

- Applicable codes of the PA Uniform Construction Code (UCC)
- ASME Codes
- ANSI B31.1 Code
- FM Global Standards

The University has a commitment to environmental stewardship and requires the maximum possible use of sustainable and energy-efficient designs and specifications, for architectural, site, utility, structural, mechanical, electrical, and plumbing work. The Professional should be aware that all designs will be reviewed by the University within this context.

The process for complying with zoning or land use regulations shall be managed by the University.

The Professional shall attend all hearings/meetings required for securing necessary approvals and permits.

The Professional shall be responsible for completing all the appropriate planning modules, soil erosion control plans and other documents which may be required.

The Professional shall be responsible for obtaining whatever permission necessary to connect to non-University owned utility lines.

4/89
Rev. 12-14-89
Rev. 8-7-91
Rev. 10-29-93
Rev. 11/98
Rev. 4-23-01
Rev. 4-27-01
Rev. 7-26-01
Rev. 10-17-01
Rev. 2-15-02
Rev. 4-15-05
Rev. 12-21-06
Rev. 2-23-07

REVISIONS OF THE DESIGN AND CONSTRUCTION STANDARDS

Changing technology and changes in University requirements will require continuing revisions and updates to the manual. All comments and proposed corrections or revisions should be directed in writing to:

Kathryn Poissant
Architect Design Services
113 Physical Plant Building
University Park, PA 16802

KAP4@nw.opp.psu.edu

After review and approval of the Committee, the revisions will be made to the web version of the standards.

All pages of revised and/or new sections will be dated in the lower left-hand corner. The most recent revisions are indicated by a vertical line in the margin next to the text. Asterisks in the margin indicate locations where text has been removed.

The revision date will also be recorded in the Date Revised column in the Table of Contents. Each user of the manual shall delete obsolete pages and insert revised pages as required.

Before starting a project for the University, all Professionals shall ensure that their copy of the Design and Construction Standards is up to date.

GENERAL NOTES TO THE PROFESSIONAL

A. Board of Trustees Submissions

1. The Professional shall be responsible for the preparation of graphic material to be presented to the University Board of Trustees when their approval is required for a project. Refer to the "Board of Trustees (BOT) Submission Requirements" on Penn State Design & Construction web page <http://www.opp.psu.edu/construction/standards/submittal_requirements/bot_guide.pdf> for specific instructions on the requirements for information and graphics, based on project cost and type.

B. Standard Drawing Size

1. Drawings shall be prepared on standard sheet sizes 24 inches by 36 inches or on sheets 30 inches by 42 inches. Use of any other sheet size requires the prior approval by the University Project Manager.

C. Planning of Support Services Area

1. During the planning and design stages of the project, the Professional shall consider the need to provide certain support service areas that may be required for a particular project but not necessarily identified in the program. The need for the following types of areas shall be reviewed, and where appropriate, included as part of the project:

   - Public Telephone Location
   - Vending Machine Location
   - Employee Lounge
   - Central Mail Room
   - Central Copy Area
   - Loading Dock

D. Retention of Existing Trees

1. To encourage the retention of mature trees which are one of the University's prime assets, and to correct the current slow depletion of the campus tree canopy, the Professional shall site the building to minimize the loss of and impact on mature trees.

2. The landscape plan for the project shall be integrated with the surrounding landscape design and it shall include trees.

E. Safety Considerations

1. Runways and ramps should be installed in all buildings where bulk supplies are handled. Ramps should have a surface providing traction.

2. All glass and glazed doors used at entrances, stairwells, etc., shall have adequate push plates or bars and proper glass as required by applicable building codes or regulations.

3. All windows in buildings (above ground floor) must be of the type which can be washed on both sides from the inside of the building. Where construction is such that this type of window cannot be installed, there shall be safety belt anchors placed at the outside of the windows for fastening safety belts and an outside ledge for standing not less than 12" wide. Safety belt anchors installed outside shall be a standard approved type. They shall not be the expansion bolt type.

4. On all windows where the stool of the window is less than two feet from the floor, there shall be bars or other approved means provided to eliminate the possibility of falls through the windows. Casement windows or other outward projecting sash will not be used at the ground floor.

5. A non-slip nosing shall be installed on all interior stairs. Nosings with grooves or other depressions tending to form trip hazards shall not be permitted. (Carborundum or similar abrasives are not permitted.)

6. All outside steps must be adequately lighted. Treads and landings should have positive drainage away from the building.

7. Suitable railings and guards shall be provided at all places such as stairwells, outside steps, bridges, loading ramps, etc. where persons are exposed to the possibility of falls from one level to another.

8. All inside lighting fixtures must be placed so relamping can be accomplished with minimum effort and hazard.

9. Chemical and flammable liquid storage and usage areas will be ventilated sufficiently to remove all fumes and shall be constructed in accord with all applicable codes and University requirements.

10. For the University piping color code and the usual painting called for under the mechanical trades, the University uses a "Color Code" for the identification of certain equipment and piping. See Division 15A.

F. Submittals

1. To assist the Contractor(s) in following through on all the various submittals that will be required of them, the Professional shall include in the contract documents, complete with the Specification section/paragraph reference, a table indicating all the shop drawings, catalog data, manufacturer's operating instructions, maintenance instructions, certificates, warranties, guarantees and any other pertinent operating and maintenance data.

G. Equipment Screening

1. All exposed exterior mechanical and electrical equipment is to be screened from view. The screening method to be employed will be determined on an individual project basis.

H. Fire Rated Construction Assemblies

1. All construction assemblies which require a specific fire rating; i.e., 1-hour, 2-hour, etc., shall be so designated on the construction drawings. In addition, the governing agency or applicable code, edition, and date shall also be indicated. The purpose of this is so that the University can maintain the required ratings when future revisions are made.

I. Contractor Pre-Qualification

1. Refer to web site <http://www.opp.psu.edu/construction/bidders/requirements.cfm> for contractor pre-qualification information.

J. Bidding/Builders Exchanges

1. A complete set of bid documents is also to be sent to the agencies listed in "Section A, Notice to Bidders" located on the Penn State Design & Construction Standards Page, **<**http://www.opp.psu.edu/construction/standards/index.cfm**>**.

K. Sustainable Design and Energy Conservation

1. All new and renewed facilities shall be Leadership in Energy and Environmental Design (LEED) certified.

2. LEED Certification shall follow the “PSU Policy based on LEED for New Construction and Major Renovations Version 2.2” found at <http://energy.opp.psu.edu/green-buildings/PSULEEDRequirementsv8.pdf>.

3. All facilities shall achieve a minimum of at least 30% energy savings over the latest version of the ASHRAE 90.1 standard. Documentation of compliance shall be according to the Energy Cost Budget Method as prescribed in ASHRAE 90.1 utilizing a whole building energy simulation.

L. Space Planning for Engineered Building Systems

1. General

a. Always design with maintenance in mind. Maintenance and housekeeping are daily activities in every campus building. The University expects these activities to be carried out in a manner that students and faculty are not aware of the effort. Similarly, buildings and improvements are needed that lend themselves to cost effective utilization of manpower in a discrete manner.

b. Design team shall fully coordinate all requirements to ensure easily accessible, unobstructed, safe, generous, sufficient space for mechanical and electrical equipment rooms and general maintenance storage when developing the building floor plans.

1) Designated mechanical/electrical equipment rooms, mezzanines and platforms shall have at least the minimum headroom/ceiling height required by building code for occupiable spaces. Crawlspaces (either basement or attic) are not acceptable plant equipment rooms.

c. Design for Safety: The plant and systems must be located and arranged to permit adequate means of escape and access for maintenance without exposing the maintenance staff to undue safety risk.

d. Design for Cost Effective Replacement: All mechanical and electrical rooms shall be located, have adequate floor area and door sizes and be internally arranged with entirely clear aisles to permit the removal and replacement of the largest piece of equipment from the space to the building exterior without dismantling other equipment or permanent building general construction.

1) Primary aisles intended to be kept clear in perpetuity for equipment replacement shall be clearly indicated on construction

drawings and with painted boundaries on final floor finishes in mechanical/electrical rooms.

2) Building design shall not require a crane to replace common systems components such as pumps, motors, fan wheels, coils, compressors, transformers, electrical gear, motor starters, etc.

3) In buildings with elevators, elevator with sufficient capacity shall extend to all levels, including roof, with mechanical/electrical equipment having any replaceable component that cannot be safely transported down stairs or ship ladders.

4) Include roof access hatches, hinged or easily removeable louvers, knockout panels or similar other architectural features as necessary for major equipment replacement that cannot be otherwise handled through routine means.

5) Coordinate between disciplines to provide adequate structural strength in all areas over which heavy equipment is required to be rolled in and out of the building.

e. Allow adequate dedicated spaces for building system control panels: local Building Automation Systems (BAS) operator workstation, associated BAS network controllers/panels, security/access control panels, fire alarm control panels, lighting control panels. These types of building operation control panels shall not be placed in spaces shared and/or the access controlled by the occupants or departments other than OPP, including but limited to the following:

1) Departmental work or storage spaces
2) TNS server room, work or storage spaces
3) Janitorial/Housekeeping

2. Mechanical

a. Mechanical rooms shall be sufficiently sized and equipment arranged to accommodate proper, efficient and safe access conditions for routine maintenance and replacement.

1) There shall be enough clear space around equipment to do such things as change filters, pull coils, removal of fans, shafts, motors, bearing assemblies, etc. without moving other equipment or building general construction.
2) Allow at least three feet between all service sides of AHU’s and other large equipment and obstructions.
3) Minimize the need to do maintenance from ladders. Provide permanent ship ladders, equipment platforms, safety rails, anchor points and lanyards, etc as required to safely access overhead equipment.
4) Provide overhead structural steel with portable chain hoists to lift and rig heavy motors, compressors, fans, etc to means of transporting out of building.
5) Consider and plan for general maintenance storage requirements in mechanical rooms.
6) Avoid tripping hazards. Arrange equipment and provide sufficient floor drains to avoid running pipes across walking paths on floors.
7) Refer to Section 230000 for appropriate environmental conditions in these spaces.

b. To the greatest extent possible, mechanical equipment shall be located indoors to maximize useful service life and for safety and ease of maintenance staff, particularly during adverse weather conditions.

c. No outdoor/rooftop primary air handling equipment is allowed without written permission from the Office of Physical Plant, Engineering Services.

1) Exceptions:

a) Unitary DX units with no hydronic or steam coils subject to freezing.

b) Renovations to existing facilities in which it is otherwise not practical or feasible to provide adequate indoor mechanical space.

i. Where otherwise unavoidable, hydronic systems subject to freezing conditions shall be protected with separate piping loops with antifreeze solution, heat exchangers, pumps, expansion tanks, as required to prevent freezing in the event of extended electrical power outage and to minimize and isolate portions of systems requiring antifreeze from the main hot and chilled water loops.

ii. Steam traps and drip legs shall be located below the thermal insulation envelope of the roof assembly.

iii. Alternatively, all sections of piping exposed to freezing conditions shall be completely electrically heat traced on circuits on normal/emergency standby power.

iv. Outdoor/rooftop equipment shall include stairs/ladders, raised platforms, gratings, and handrails for adequate access to all main components.

v. Provide adequate safety and visual screening.

d. Locate primary air handling equipment and all pumps, heat exchangers in dedicated mechanical rooms, never above ceilings.

e. Acoustically treat rooms and/or equipment to contain equipment noise.

f. Include stairway or ships ladder to any equipment on the roof. Review with OPP and obtain approval if vertical ladders are only practical solution for existing facilities.

3. Electrical

a. Service entrance electrical room:

1) A dedicated shall be located on the perimeter of the building immediately adjacent to the pad-mount transformer.

2) The electrical room shall have a physical separation from the other spaces in the building (including mechanical equipment rooms) with a minimum fire resistance rating of one hour (review code for stricter requirements).

3) Heating and ventilation of the main electrical room shall be dedicated to that room, and ventilation air shall not be transferred from adjacent spaces. Consider how air flow through the space will best cool any heat producing equipment.

4) Size to allow for future growth of the service entrance equipment of at least 25% of design requirements. There shall be adequate initial space and "future" space to allow the installation of additional sections equal in size to the switchgear required for this project.

b. If the service requires switchgear, it shall be located in the center of the room and shall allow for working clearance on ALL four sides of the equipment.

c. Electrical distribution panel rooms/closets shall be dedicated spaces, with room for additional panelboard sections in the future. Transformers shall be floor mounted.

d. Engine generators, when required, shall be placed on grade at the exterior or within the building. At no time will this equipment be installed above grade level or on a roof. Give consideration as to the survivability of this equipment; do not locate adjacent to the service transformer or below grade where it may be flooded.

M. Janitorial Facilities

1. Janitorial facilities will vary according to size, type, and use of the building, but in general 200 sq. ft. of useable custodial space shall be provided for each 20,000 gross sq. ft. of building area. The number of rooms, size and location shall be considered during preparation of preliminary studies and specific needs shall be determined in consultation with the Operations Division. At least one room per floor is required.

2. Mechanical Equipment: Mechanical, OTC, computer, or electrical equipment or controls shall not be located in janitorial facilities. A janitorial area shall not be used as access to mechanical equipment or other service areas.

3. Main Janitor Room:

a. Location: The preferred location for the main janitor room is on the ground floor close to a service entrance, delivery area or elevator.

b. Size: The minimum size shall be 200 square feet to be increased accordingly depending on the size of the building. The following guidelines apply:

20,000 sq. ft. and less	-- 200 sq. ft.
20,000 sq. ft -- 100,000 sq. ft.	-- 300 sq. ft.
100,000 sq. ft. -- 200,000 sq. ft.	-- 500 sq. ft.
200,000 sq. ft. plus -- consult with Operations Division	

c. Sufficient space shall be provided for the storage of the custodial equipment and for the custodians to eat their lunch.

d. In buildings with 50,000 square feet and greater this space shall be subdivided to provide a separate locker and break area and an equipment/supply storage area.

e. Locker Area: The locker area shall be of sufficient size to accommodate all of the janitors for the building, based on one janitor for each 20,000 square feet of floor area to be cleaned. The room shall be sized to permit furnishing with locker and chair for each janitor and a 28 inch x 42 inch table or desk. The room shall be heated, lighted, ventilated and equipped with sink, 16 inch x 20 inch mirror, hot and cold water, 36 inch x 42 inch bulletin board, paper towel dispenser, soap dispenser, two electrical receptacles (110V), and door with separate keyed lock. The door shall be 36 inches wide with proper ventilation where required. Locker size: 15" wide, 18" deep, 72" high and slanted top. Minimum size of locker rooms shall be 200 square feet.

f. Equipment/Supply Storage Area: The equipment/supply area shall be of adequate size to provide space for janitor's carts, broom racks, mop racks, ladder racks, vacuum cleaners, floor care equipment, and shelving for a minimum of one month's supply of soap, toilet paper and paper towels. There shall be space under the bottom shelf for storage of mopping units, metal tubs and pails. The room shall have heat, light, ventilation, bulletin board and door with lock. Provide 110-volt, single-phase, 20-amp outlets on a separate circuit in these rooms for charging battery-powered equipment.

g. Refer to 112400 – Maintenance Equipment for additional requirements.

4. Satellite Custodial Areas:

a. Location: Satellite custodial areas shall be located on the upper floors of multistory buildings preferably near restrooms. In major buildings more than one space per floor is necessary. for efficient time management of work force and emergency situations.

b. Size: In general, 50 sq. ft. is minimal. The combined square footage of satellite spaces plus the main janitor room determines the adequacy of a building's janitorial facilities. Unusual design or shapes of satellite custodial space (i.e., long and thin, triangular, etc.) shall be avoided in order to maximize the useable space.

c. Equipment: Satellite custodial areas shall be equipped with a terrazzo floor level service sink, a small storage area, and shelving for small supplies. The closets shall have light, ventilation, two electrical receptacles (110V), and door with lock. The light shall have a protective lens that radiates light.

d. Doors: All doors to janitorial facilities shall swing out to maximize useable space. They shall be keyed to the Maintenance and Operations janitor room keying system. The doors shall be 36 inches wide with proper ventilation where required.

e. Refer to 112400 – Maintenance Equipment for additional requirements.

5. Other:

a. Outlets in corridors every 25 feet if carpeted and every 50 feet if non-carpeted. Also provide outlets within 10 feet of building entrances and on every floor landing in the stair wells.

N. Unisex Toilet Rooms

1. All buildings shall have unisex toilet rooms in the following locations:

   a. On the main floor level.

   b. On every floor level other than the main level, except where a unisex toilet room exists on the floor above and the floor below.

   c. Where required by code.

2. Every project shall consider the location of existing unisex toilet rooms, and shall include the construction of additional toilet rooms to meet the requirements of the preceding paragraph. No exception is given to any project, except with written approval from the Manager of Design Services, Office of Physical Plant.

3. All unisex toilet rooms shall meet the requirements of the Americans with Disabilities Act Accessible Guidelines.

4. Contact the Manager of Design Services, Office of Physical Plant, for signage, plumbing fixtures and toilet accessories requirements.

O. Loading Dock Facilities

The Professional's attention is directed to the installation at loading docks and shipping and receiving areas where a canopy or roof structure may interfere with the loading and unloading of freight. The height of loading dock platforms and the height of overhead structures should be such that trucks may gain access to the dock in both loaded and unloaded conditions, compatible with facility use requirements.

P. Refuse Container Locations

1. The University Park and most Commonwealth Campuses use the Dempster system of collection. This system employs the use of six (6) and eight (8) cubic yard metal containers and a twenty-four (24) yard capacity packer-type truck to mechanically lift and dump the cans. The overall dimensions of the containers are 80 1/4 inches wide (for any size) x 59 1/4 inches x 76 inches high (based on standard six (6) yard container).

2. Containers should not be located under roof overhangs, immediately next to combustible building construction or next to window openings. Additionally, containers shall not obstruct doorways or fire protection system devices (hydrants, siamese connections, sprinkler control valves).

3. A 31 cubic yard refuse truck measures 30'-3" long overall and has a wheel base of 158 inches and an overall height of approximately 12 feet, 6 inches. An overhead clearance of approximately 20 feet is required to dump a six-yard box. The gross weight on front axle is 15,000 pounds, rear tandem axles 38,000 pounds.

   Note: Measurements will vary depending on cubic capacity size of vehicle.

4. To service a container requires the truck operator to approach the container on an axis normal (90°) to the 80 1/4 inch width of the container.

5. It is preferred that the trash and recycling containers be located at road level immediately adjacent to the loading platform of the building for convenient top loading from the platform.

6. A concrete pad 9 feet wide by 8 feet shall be provided for each container required. The surface of the concrete pad shall be on a place parallel to the road surface where the truck stops to service the container. This is necessary to properly engage the lifting forks of the truck in the sockets of the container to be lifted.

7. The service road to the container shall be a minimum of 12 feet wide and of suitable construction to support the axle loads mentioned.

8. To turn the packer truck requires a 45 foot radius and a minimum road width on the curve of 20 feet. If servicing of the container requires turning the truck, then the above turning radius and minimum road widths should be provided.

9. Refuse: The University requires one 8-yard Dumpster for every 100,000 sq. ft. of building space for every 8 hours of use.

10. Recycling: The University requires two types of containers: one 6 yd3 for mixed office paper and one 6 yd3 for cardboard.

11. For each project, the A/E is required to consult with the OPP Solid Waste Management Foreman to determine exact needs, based on facility type, size, and location.

DIVISION 00 – PROCUREMENT AND CONTRACTING REQUIREMENTS

00 00 00 PROCUREMENT AND CONTRACTING REQUIREMENTS

.01 These sections are no longer included in this manual. Please refer to "Front-End Specifications" located on the Penn State Design & Construction Standards Page, http://www.opp.psu.edu/construction/standards/index.cfm.

DIVISION 01 – GENERAL REQUIREMENTS

01 00 00 GENERAL REQUIREMENTS

.01 These sections are no longer included in this manual. Please refer to "Front-End Specifications" located on the Penn State Design & Construction Standards Page, http://www.opp.psu.edu/construction/standards/index.cfm.

DIVISION 02 – EXISTING CONDITIONS

02 00 00 EXISTING CONDITIONS

.01 This section is reserved for future use.

DIVISION 03 – CONCRETE

03 00 00 CONCRETE

03 00 10 Owner General Requirements and Design Intent

.01 General

A. Air-entraining is to be specified for all concrete exposed to weather.

B. The use of admixtures will be permitted only for air-entraining agent in specified type concrete. In this event, the concrete mix shall be adjusted to compensate for the admixture in a manner approved by the Professional.

C. Antifreeze and other admixtures will not normally be permitted.

D. On all exposed concrete floors, a hardener and dustproofing agent shall be used.

E. All suspended concrete floors, including those in penthouse mechanical rooms, shall be watertight.

.02 Field Testing of Concrete

A. During the progress of construction, tests will be required to determine whether the concrete being produced complies with the standard of quality and strength as specified.

B. The Contractor shall retain and pay for the services of a qualified laboratory to perform all testing.

C. Compressive Strength Tests: Four cylinder will be made for each class of concrete used in any one days' operation or for each 100 cubic yards or portion thereof of concrete placed.

D. The standard age of the tests shall be 7 and 28 days and tabulated results shall be furnished to the Architect and the University.

E. Air-Entrainment Tests: Tests of air-entrained concrete shall be made to determine the percentage of air entrained in the concrete. These tests shall be performed in accordance with PennDOT 408, Section 704.1(c)1, by a qualified testing laboratory retained by the Contractor. Test results shall be furnished to the Professional and the University.

DIVISION 04 - MASONRY

04 00 00 MASONRY

04 00 10 Owner General Requirements and Design Intent

.01 General

A. A sample brick panel of 100 face brick selected for the project shall be laid up with specified jointing for approval by the Professional and the University prior to starting exterior face brick installation.

Should the initial sample panel be unsatisfactory, the Contractor will be required to erect additional samples until the brick work and jointing are approved by both the Professional and the University.

B. Admixtures: Setting accelerators or antifreeze compounds will not be permitted.

C. Unless adequate protection against freezing is provided, no masonry work is to be done when the temperature is below 36°F or predicted to be below 36°F overnight.

D. Water Repellent Treatment: All exterior masonry work shall receive a water repellent treatment after cleaning with a non-staining, water repellent, gum resin solution.

Silicone coatings are not acceptable.

E. Coping Stones:

1. All coping stone joints shall be raked to a depth of 1/2" and caulked.

2. Thru-wall flashing shall be installed beneath all coping stone installations.

F. Efflorescence: Particular care must be taken in the selection of materials and in design and detailing of exterior walls to prevent efflorescence in brickwork. Certification shall be provided that brick and any masonry trim material has passed the "wick" test (ASTM C67).

DIVISION 05 - METALS

05 00 00 METALS

05 00 10 Owner General Requirements and Design Intent

.01 General

A. Ornamental Metal Work (Architectural)

The University prefers that ornamental metal work, if possible, be constructed of anodized aluminum.

B. Metal Handrails Interior

1. Handrails should be aluminum or plastic covered steel.

2. Handrails of rectangular cross sections are not acceptable.

3. Rails shall be oval or round.

4. Rails shall not terminate with open ends. They shall return to wall or in the case of an isolated center rail, it shall return to the post.

5. Where rails change direction, the corner shall be made with as large a radius as possible.

C. Metal Handrails Exterior

Exterior steps should have railings at open sides and a center railing, if required by applicable code, of bronze or aluminum, not less than two (2) inches in diameter, and securely anchored.

D. Caps

Where end caps or post caps are required, they should be permanently fastened by welding or with rivets or screws which cannot be easily removed.

DIVISION 07 – MOISTURE PROTECTION

07 00 00 MOISTURE PROTECTION

07 00 10 Owner General Requirements and Design Intent

.01 Roofing Systems

A. The University relies on proper design, materials selection, and rigid inspection for adequate performance of roofing systems. Roofing systems shall be installed according to manufacturer's recommended installation procedures.

B. All roofing systems shall meet the appropriate FM Global criteria for wind loss prevention.

C. All roofing systems shall have a class "A" rating as listed by Underwriters Laboratory, Inc., for fire resistance and all products shall bear the appropriate listing mark or classification marking and the company's name, trade name, trademark, or other recognized identification.

D. Roofing systems will be reviewed with the Professional on a project-by-project basis, and the University reserves the right to change details as job conditions dictate.

E. All roofs must have a minimum of 1/4" per foot slope.

F. Provide special surface treatment, that does not block drainage, at roof areas subject to foot traffic.

G. The University discourages the use of APP (Atactic polypropylene) modified bitumen systems.

07 10 00 DAMPPROOFING AND WATERPROOFING

.01 Waterproofing--Dampproofing

A. At all suspended interior floor areas where restrooms, toilets, showers, and similar type water-use facilities are located, a membrane waterproofing material shall be used.

B. Below-grade foundation walls and all masonry work shall be dampproofed and/or waterproofed to meet design requirements and site conditions.

C. Exterior slabs and/or deck areas which allow weather exposure to building interior shall be waterproofed by positive water stops of metal, plastic, and/or membrane waterproofing built into the work.

07 20 00 THERMAL PROTECTION

.01 Roof Insulation

A. The University discourages the use of vegetable or cane fiber-type board insulation.

B. Expanded plastic can be installed unprotected on concrete roof decks. On metal decks, a base layer of 5/8" moisture resistant, fire-rated gypsum board may be used prior to installation of expanded plastic insulation or a combination expanded plastic and gypsum or perlite base layer-type insulation may be used.

C. All proposed roof insulation systems shall be reviewed by the University during the project design stage.

07 60 00 FLASHING AND SHEET METAL

.01 Flashing

A. The specifications and details of the National Roofing Contractors Association shall be used as guidelines for all roof flashing systems.

B. All flashing shall have a minimum height of eight inches (8") above finished roof membrane.

07 70 00 ROOF AND WALL SPECIALTIES AND ACCESSORIES

.01 Roof Penetrations

A. Pitch pockets generally will not be permitted. If pitch pockets are to be used they must be reviewed by the Professional with the University. Design of all roof penetrations shall be in accordance with the recommendations and details of the National Roofing Contractors Association.

B. All roof penetrations shall have a minimum 12" clear between penetrations, and all roof penetrations shall have a minimum 12" clear between penetrations and perimeter of roof.

C. Mechanical equipment stands shall adhere to the following schedule:

Minimum Height Standards

Width of Equipment	Height of Legs
Up to 24"	14"
25" to 36"	18"
37" to 48"	24"
49" to 60"	30"
61" and Wider	48"

.02 Roof Drains

A. Roof inlets generally shall be of Dura-coated cast iron body, dome strainers, setting and clamping rings, extension sleeves, sump receivers, etc.

B. Roof drains shall be installed at low points, or mid-span, and not at column locations, and preferably in a designed sump.

C. Flexible connectors shall be used between drain bodies and rainwater conductors.

DIVISION 08 - DOORS, WINDOWS, GLASS, AND HARDWARE

08 00 00 DOORS, WINDOWS, GLASS, AND HARDWARE

08 10 00 DOORS AND FRAMES

.01 Exterior Door Frames

A. Exterior door frames shall be heavy duty, hot-dipped galvanized metal.

B. Aluminum shall be anodized in selected finish.

C. Door frames shall have reinforcement plates for the attachment of all hardware.

D. All exterior frames shall be weather stripped.

.02 Exterior Doors

A. All exterior doors should be of metal, heavy duty, galvanized, and seamless construction.

B. Aluminum doors shall be anodized in selected finish.

C. Narrow stile type metal doors are not acceptable. Stiles and top rail shall be a minimum of five (5) inches and bottom rail shall be a minimum of ten (10) inches.

D. Automatic hold-open devices are not permitted on exterior doors.

E. Use of single doors or multiple doors with mullions is preferred.

NOTE: See General Notes to the Professional, Paragraph E.2.

.03 Interior Doors - Wood

A. Specifications for interior doors of wood shall be adapted from standards of the following manufacturers:

Doors to be 1 3/4" thick solid core, flush.

1. Algoma Hardwoods

2. Weyerhauser

B. It is preferred that wood doors be prefitted and prepared for approved hardware at the place of manufacture.

C. It is preferred that wood doors be prefinished for natural finishes and presealed for doors to receive paint.

D. Doors from corridors to stairwells and classrooms shall have a vision panel.

E. All cut-outs for vision panels, louvers and similar items shall be accomplished at the factory. Manufacturers shall provide reinforcement members (if required), prefitted, prefinished mouldings, trim and all glazing beads.

F. Provide mullion for all multiple door openings.

G. Louvers, if required, shall be provided by the door manufacturer.

08 50 00 WINDOWS

.01 Windows

A. All sash and frames are to be anodized aluminum in selected finish with thermal barrier construction. If operable, using sliding, projected, or hopper with integral weather stripping; no outward projecting sash will be permitted on the ground floor. Windows shall be double glazed Anodized aluminum to be treated to prevent etching from aluminum residue.

B. For maintenance purposes, all windows should be arranged, manufactured, and installed, so that complete maintenance can be accomplished from the room side. This should include glazing, washing, screening, and normal repairs.

C. Windows with fixed sash should be designed to allow the "fixed" sash to be operable only for cleaning and maintenance; i.e., utilize side pivoted or tilting type sash at normally "fixed" sash locations in high-rise buildings.

D. Consideration should be given to the use of tinted glass or special structural design at certain areas where orientation will lead to excessive solar heat gain.

NOTE: See General Notes to the Professional, Paragraphs E.3 and E.4.

08 70 00 HARDWARE

.01 Finish Hardware Requirements

A. Office Doors:

Locksets and trim shall be similar to Sargent #8205 WTJ. No door closers, unless required by codes.

OPERATION: Latch bolt operated by lever either side except when outside lever is locked by button or toggle in faceplate; latch is retracted by key outside. Auxiliary bolt deadlocks latch.

B. Classroom Doors:

Locksets and trim shall be “CLASSROOM FUNCTION:”

1. Guardbolt deadlocks latchbolt
2. Latchbolt retracted by either trim unless outside trim is locked by key
3. Key outside locks or unlocks outside trim
4. Inside trim always operative
5. Latchbolt can be retracted by key in locked position
6. Handles to be break-away levers except where Codes requires panic bars

Closers shall be LCN, or equal, type 4010 or 4110 series allowing 180 degrees of swing where conditions permit.

Inactive leaf of double doors shall have mortise flush bolts head and foot similar to IVES #457 x dustproof strikes.

See Division 13 20 10 for further references to the General Purpose Classroom document that includes information on doors and hardware in that document.

C. Laboratory Doors:

Locksets and trim shall be similar to Sargent #8225 WTJ.

Closers shall be LCN, or equal, type #4010 or 4110 series allowing 180 degrees of swing where conditions permit.

Inactive leaf of double doors shall have mortise flush bolts head and foot similar to IVES #457 x dustproof strikes.

OPERATION: Latch bolt by lever either side. Dead bolt by key outside and turn piece inside. When dead bolt is projected, latch bolt is deadlocked and outside lever is locked. Turning inside lever retracts latch and dead bolt simultaneously--automatically unlocking outside lever.

D. Storage Room Doors:

Locksets and trim shall be similar to Sargent #8224 WTJ. No door closer, unless required by codes.

OPERATION: Latch bolt by lever either side. Dead bolt by key outside and turn piece inside.

E. Janitor Closet, Janitor Storage, and Utility Room Doors:

Locksets and trim shall be similar to Sargent #8204 WTJ. No door closers, unless required by codes.

OPERATION: Latch by lever inside and key outside. Outside lever always rigid. Auxiliary latch deadlocks latch bolt.

F. Public Toilet Doors:

Each door shall have pulls similar to Rockwood #FB110-70B and 18-gauge stainless steel push plates. Closer shall be LCN or equal, type 4010 or 4110 series. Provide Glynn-Johnson GJ 45 kickdown door holder if permitted by applicable code.

OPERATION: Push and pull. Use latch set where required by codes. Latch bolt retracted by either lever.

G. Communicating Doors:

Locksets and trim shall be similar to Sargent #8226 WTJ. No door closers, unless required by codes.

OPERATION: Latch both by lever either side. Dead bolt operated from either side by key.

H. Stair Tower Doors:

Exit devices and trim shall be similar to Von Duprin #99L-F-BE x #992L-R-03 for single doors or #9927EO-F x #9927L-F-BE x #992L-V-03 for double doors. Should be surface-type exit devices.

Closers shall be LCN, or equal, type 4010 or 4110 series without holder arms.

OPERATION: Latch automatically when closed. Latch bolt by lever outside and touchbar inside. No dogging.

I. Exterior Doors (including aluminum doors):

Exit devices and trim shall be similar to Von Duprin #33NLx333NL for single doors or double doors with removable mullions, or #3327DT x 333DT x 3327NL x 333NL for double doors. Should be surface-type exit devices.

Closers shall be LCN, or equal, type 4010 or 4110 series without holder arm. Doors shall have substantial holders and bumpers to manually hook doors in open position.

OPERATION: Lock automatically when closed--key retracts latch bolt. When touchbars are locked down by Allen-type dogging key, latch bolt is retracted and doors operate push-pull.

J. Vestibule Doors (including aluminum doors):

Each door shall have pulls and push bars similar to the exterior doors.

Closers shall be LCN, or equal, type 4010 or 4110 series without holder arm. Doors shall have substantial holders and bumper to manually hook doors in open position.

OPERATION: Push and pull.

K. Dormitory Bedroom Doors:

Locksets and trim shall be similar to Sargent #8225 WTJ.

Closers shall be LCN, or equal, type 4010 or 4110 series.

Kick plates and mop plates shall be 18 gauge stainless steel beveled top and two (2) sides.

OPERATION: Latch bolt by lever either side. Dead bolt by key outside and turn piece inside. When dead bolt is projected, latch bolt is deadlocked and outside lever is locked. Turning inside lever retracts latch and dead bolt simultaneously--automatically unlocking outside lever.

L. Uncontrolled Library Exit Doors:

All doors shall be equipped in conjunction with the exterior door hardware with an emergency exit alarm similar to Detex EA-2500 series exit alarm.

The emergency exit alarm locks may be key operated from the inside or outside or both as directed by the University and Architect.

M. Lock Cylinders:

All cylinders shall be (7) pin removable core type as manufactured by Best Lock Corporation, keyed and masterkeyed according to schedules which will be prepared by the University - Office of Physical Plant. Furnish two (2) keys with each cylinder and three (3) master keys.

All keys shall be embossed with the letters "P.S.U." and stamped "DO NOT DUPLICATE" and the door number or other symbol as directed.

The Contractor shall use construction cores furnished by the lock company and return same when the permanent cores are installed.

All key-operated elevator switches to be provided with Best cylinders only.

All Best cylinders shall be specified under the Finish Hardware Section.

N. Hinges:

All doors shall be equipped with proper type, size, and number of hinges as recommended by Stanley or McKinny Hinge Division. All hinges shall have button tips and non-removable pins for exterior doors opening out.

O. Door Stops, Holders and Bumpers:

All doors shall be provided with stops similar to Glynn Johnson GJ-WB-50C where possible. Where required, floor stops shall be similar to GJ-FB-13 or GJ-FB-17, overhead stops and holders GJ-90 series and holders and bumpers GJ-F9X, F20, or GJ-W-20.

Do not specify automatic holders for exterior doors.

P. Finishes:

All hardware shall be satin chrome (US26D), except pulls, push plates, kick plates and mop plates shall be satin-finish stainless steel (US32D), unless otherwise specified.

Q. Miscellaneous Requirements:

All push plates where possible shall be 8" x 16" in size.

All doors with push plates and pulls with the cylinder on the push side shall have recessed pulls similar to Rockwood #94C used in conjunction with the push plates.

Provide rubber silencers, similar to GJ-64 for all doors in hollow metal frames, except exterior doors.

Supply padlock (if required) with Best (7) pin core keyed to building master.

Furnish padlocks for all transformer gates.

All doors with closers shall be provided with kick plates.

All door closers for wood doors to be furnished with thru bolts and grommet nuts.

All doors as specified shall have surface-mounted overhead closers, full rack and pinion type, with back check, as manufactured by LCN or equal.

Exterior or vestibule doors where conditions would be better suited for floor closers, use Rixson #27 series or equal including an intermediate pivot.

All flush bolts to be installed in edge of doors.

Non-metallic insert type latch bolts will not be acceptable as antifriction unless used with curved lip strike.

"Total Door System" hardware is not acceptable.

All hardware for aluminum doors shall be specified under the finish hardware section.

No automatic hold-open devices permitted on exterior or vestibule doors.

Hardware schedules shall be done in the vertical format type. Horizontal format will not be accepted.

For locksets with lever handle, trim design shall be similar to Corbin-Russwin LSM or Sargent WTJ.

All hardware must be in accordance with the latest requirements of all applicable codes.

08 80 00 GLAZING

.01 Glass and Glazing

A. Windows are to be double glazed, flush-type moulding preferred.

B. Glazing, glazing compounds and sealants. (1) Refer to manufacturer's requirements and Flat Glass Jobbers Association (FGJA) "Glazing Manual" for special applications using elastic compounds, tape, polysulfide elastomer sealants, and compression materials.

C. All glass and glazing shall be in compliance with applicable codes.

DIVISION 09 - FINISHES

09 00 00 FINISHES

09 00 10 Owner General Requirements and Design Intent

.01 Schedule of Finishes

A. Professional Note: Finish schedules will be developed with University concurrence on a project-by-project basis.

B. The Professional will be required to prepare and submit to the University for approval, a schedule of finishes accompanied by a complete color board showing all finishes, color chips, and material samples of scheduled finishes and specified and/or approved alternate materials. This submission will be required prior to approval of final plans.

C. Particularly careful attention must be given to the selection of color. In addition to all other considerations, maintain-ability is an important factor that must be included in the selection process. Past experience at the University indicates that certain colors and color ranges do not hold their good appearance under normal usage. For instance, dark colors have a tendency to show scuff marks more so than light colors, while greys and light greens show less scuff marks than any other colors the University maintains.

D. At stairwells, landings, and stair treads, consideration must be given to maintenance in the selection of floor covering materials.

1. Dark colors shall not be used.

2. The material must be smooth, no grooves or ridges permitted.

3. The material should be non-slip, but not of abrasive materials.

E. Ceramic Tile Floors: Where ceramic tile is used at floor areas, the installation should be specified to conform with the recommendations of the Ceramic Tile Institute.

F. Wood Gymnasium Floors: All wood gymnasium floors shall be specified to receive the following finish system:

Two coats of Hillyard Trophy Wood Seal #348 followed by two coats of Hillyard Trophy Gym-Finish #278.

G. The preferred materials and finishes for interior walls are those which are durable, easily maintained and resistant to normal occupancy damage. The use of vinyl wall covering and wood paneling will be considered for specific areas.

09 50 00 CEILINGS

.01 Ceilings, Suspended Acoustic

A. Suspended ceiling systems should be of the type that allows the ceiling material to be removed from its supporting framework, or otherwise removable, and replaceable, without refinishing.

B. Do not permit the attachment of lighting fixtures directly to the ceiling grid system without proper reinforcement of the ceiling suspension system.

C. All ceilings at areas that may have mechanical equipment above which will require periodic servicing, maintenance and/or filter changing shall be so constructed that access to the equipment may be gained without removal of major ceiling support devices or dismantling and replacement of the ceiling system. Access panels shall be clearly identified.

09 90 00 PAINTING AND COATING

.01 Paint

A. Finish Materials

1. Shall conform to applicable code for flame/fuel/smoke ratings requirements.

2. Shall be stored and applied in environmental conditions required by manufacturer's instructions.

3. Shall be ready-mixed, except field catalyzed coatings, of good flow and brushing properties, capable of drying or curing free of streaks or sags.

4. Shall be applied in accordance with manufacturer's instructions.

5. All new work shall be a three-coat system. Different shades of color shall be used for each coat. The number of coats for existing work shall be as required to equal new work.

    a. Primer--one coat
    b. Finish--two coats

6. Shall be best quality grade.

B. Finishes

1. Interior coats must be washable, except where flat finishes are used.

2. Interior wall paints shall be semigloss finish. No flat finish shall be permitted. Professional Note: Where the wall substrate is drywall, continuing runs of wall of more than 25 feet shall be avoided, especially in corridors.

3. Finish for trim shall be enamel for painted finish and varnish for natural wood finishes.

4. Finish for ceilings may be flat except in areas such as toilet rooms, shower rooms, locker rooms, wet-type laboratories, and the like, where a semigloss shall be used.

5. Piping in mechanical and boiler rooms and above finished ceilings does not have to be painted, except for external corrosion-control piping. All other exposed piping shall be painted a color appropriate to the space.

C. Manufacturer shall be one of the following:

1. M.A.B.
2. P.P.G. Industries
3. Sherwin Williams
4. Approved equal

.02 <u>University Mechanical Color Code</u>

NOTE: This section has been revised and relocated to Division 23 05 01.06 C.

.03 <u>Door Lettering</u>

A. Lettering and renumbering on doors is discontinued. (Refer to Signage Manual for requirements.)

DIVISION 10 - SPECIALTIES

10 00 00 SPECIALTIES

10 00 10 Owner General Requirements and Design Intent

.01 Electric Water Coolers

A. Consideration shall be given to functional areas when placing electric water coolers. A water cooler shall be located near or in each major functional area of a building.

10 10 00 INFORMATION SPECIALTIES

A. Chalkboards, Corkboards: Refer to Division 13 20 10 – Classroom Design.

10 13 00 Directories

A. Directories should be constructed of extruded aluminum, anodized in selected finish.

B. Include changeable letter strips slotted to receive letters. Letter strips should be approximately seven inches by one-half inch of plastic or felt-covered in selected colors. Letters and numerals shall be plastic one-quarter inch Gothic. Type of selected color shall be provided in adequate quantity to suit board size.

C. Directories shall be surface mounted, non-illuminated, DavSon Strip Directories Style SE as manufactured by A.C. Davenport & Son Company, or an equal product.

D. Doors or panels shall be glazed with DSB sheet glass and have suitable hardware with a tamperproof locking device.

10 14 00 Signage

A. See Penn State Signage Manual for details.

10 20 00 INTERIOR SPECIALTIES

.01 Toilet Room Partitions

A. Toilet partitions may be of metal or laminated plastic.

B. All toilet partitions, compartments, screens, etc. shall be ceiling or wall hung.

C. Exposed assembly and hardware screws should be one-way security type.

D. Provide clothing hook on inside face of doors.

10 28 13 Toilet Accessories

.01 Toilet Room Accessories

A. Provide a wall-mounted shelf rack 24" long similar to Vogel Peterson. Custom unit; hook style (Series 300).

B. Mirror and shelf assembly shall be similar to Bobrick B-292 Series stainless steel mirror/shelf combination units.

C. Soap dispensers shall be Kimberly Clark "Twinpack". One dispenser shall be installed for each pair of lavatories. Install on center line between lavatories.

D. Toilet tissue dispensers shall be Kimberly Clark "JRT" Junior Twin Jumbo Roll Type.

E. Sanitary napkin dispensers to be one-product vending, viz: napkin, (Stayfree No. 4 folded) as manufactured by Rochester-Midland Corp., P. O. Box 1515, Rochester, NY 14603, Model 4J, coined for 25 cents. In buildings of intense female physical activity, dispensers are to be two-product vending, viz: napkin and tampons, Model J2, coined for 25 cents, by Rochester-Midland Corp.

F. Sanitary napkin disposal units shall be Bennett Model 20L as manufactured by Bennett Manufacturing Co., Inc. 13315 Railroad Street, Alden, NY 14004.

G. Paper towel dispensers shall be Kimberly Clark "Lev-R-Matic".

10 40 00 SAFETY SPECIALTIES

.01 Fire-Fighting Equipment

A. Fire Extinguishers: Provide fire extinguishers to meet NFPA 10, BOCA, and Pa. L&I Standards. Provide one extinguisher for every 2,500 square feet of floor space plus additional strategically located extinguishers placed where the risk of fire is greater. The extinguisher shall be the dry power type, ten pound, rated 4A.60B.C.

B. Fire extinguisher cabinets shall be canopy recessed type as manufactured by Standard Fire Hose Company or approved equal, constructed with 18 gauge steel with enameled steel or stainless steel trim and clear Plexiglas bubble door with enameled steel or stainless steel frame. Doors shall have continuous hinge.

C. Mounting of all extinguishers and cabinets shall comply with all applicable standards (NFPA, BOCA, Pa. L&I, ADA, etc.).

   1. Bottoms of all cabinets shall permit sliding the extinguisher without restrictions from the cabinet.

D. Review of fire extinguisher locations and sprinkler systems requirements will be made by the University Department of Environmental Health and Safety and the University's insurance underwriter during the design of the project.

E. Automatic suppression systems: Refer to Division 21 – Fire Suppression.

F. See also Division 28 21 00 – Fire Detection and Alarm

10 50 00 STORAGE SPECIALTIES

.01 Coat and Hat Racks

A. Provide coat and hat racks in laboratories and offices. Racks shall be of metal, preferably anodized aluminum, and shall be securely bracketed to the wall and shall consist of a slat-type hat shelf and two rows of coat hooks below, one forward of the second row. Racks shall be designed and installed so that they are not hazardous to people walking nearby.

B. See Division 13 20 10 Classroom Design for further references to the General Purpose Classroom document that includes information on coat and hat racks.

DIVISION 11 - EQUIPMENT

11 00 00 EQUIPMENT

11 10 00 VEHICLE AND PEDESTRIAN EQUIPMENT

11 13 00 Loading Dock Facilities

A. Loading dock truck bumpers shall be moulded rubber or of the type that employ the use of laminated tire cording held together with galvanized bolts passing through cording and attached by heavy galvanized metal angles securely anchored to the structure.

B. The Professional's attention is directed to the installation at loading docks and shipping and receiving areas where a canopy or roof structure may interfere with the loading and unloading of freight. The height of loading dock platforms and the height of overhead structures should be such that trucks may gain access to the dock in both loaded and unloaded conditions, compatible with facility use requirements.

11 20 00 COMMERCIAL EQUIPMENT

11 24 00 Maintenance Equipment

.01 Floor and Wall Cleaning Equipment

A. Provide mop drying racks in accordance with Details 11 24 00.01 (previously 6-A) and 11 24 00.02 (previously 6-B).

11 50 00 EDUCATIONAL AND SCIENTIFIC EQUIPMENT

11 53 13 Laboratory Fume Hoods

.01 General Purpose Constant Volume Fume Hoods

A. General purpose fume hoods shall have double wall end panels with the front of the panel of the hood opening radiused, providing a streamlined section which will insure a smooth, even flow of air into the hood. The hood interior and panels shall be flush with the entrance shape to prevent eddy currents and backflow of air. The area between the double wall ends shall be closed to house the sash counterbalance weight and such plumbing lines and remote control valves as are required. The overall depth of the hoods shall be approximately 37 inches and the working surface shall be approximately one (1) foot less than the overall width of the hood.

B. At the bottom of the hood opening shall be installed an air foil which presents a streamlined appearance similar to the sides. This foil shall be mounted with a one inch open space between the foil and the bottom front edge of the hood to prevent any backflow of air at this point. The air foil shall extend back under the sash so that the sash closes on top of the foil.

C. Hoods shall be equipped with an automatic air bypass at the top of the sash opening. The bypass shall limit the maximum air velocity through the face of the hood and provide a relatively constant volume/velocity of air through the sash opening (regardless of sash position) when hood exhaust fan is in operation. The hood bypass shall not be dependent on mechanical or electrical linkage and shall be completely positive in operation. Arrangement shall be generally as shown schematically on the drawings.

D. The working surface of the hood shall have a six inch wide raised ledge conforming to the interior liner of the hood to confine spillage away from the face of the hood. Working surface to be 1 1/4" cast epoxy resin.

E. The hoods shall be equipped with a vertical sliding sash, glazed with 3/16" tempered safety sheet. The glass shall be mounted in a polyvinyl chloride extruded frame to eliminate corrosion potential.

F. The sash shall be counterbalanced with a single sash weight and sash cable system to prevent any tilting of the sash during operation and shall work smoothly and freely in the sash guides when operated from either end of the sash. The sash cables shall be of stainless steel and shall operate on ball bearing sheaves. Spring type counterbalance will not be acceptable.

G. Hood services shall consist of a cup sink and plumbing and electrical services as shown on the drawings or other type sink as may be shown on the drawings. Plumbing services are to be composed of remote-controlled valves located within the end panels and controlled by handles projecting through the vertical facia panels of the hood. Valves shall be connected to flanges and hose connectors located on the end panels within the hood. The portions of the fixtures exposed within the hood shall be brass and given a chemical resistant metallic bronze finish, or a highly chemical resistant, inert plastic finish, and the portions of the fixtures exposed on the hood exterior shall be high impact plastic. The valve handles are to be identified with index plates, with the service indicated by symbol and proper color code. The fixture services shall be pre-plumbed to the exterior of the hood for easy access.

H. A two-tube fluorescent light fixture including cool white lamps of the longest practical length shall be provided at the top of the hoods. The light fixture shall be shielded from the hood interior by a 1/8" polycarbonate safety panel sealed into the hood body with chemical resistant rubber channels.

Hoods shall be prewired to National Electric Code standards for 20 amp services. Duplex receptacles shall be 115 volt, 20 amps on separate circuits. (See Detail 11 xx xx.xx) Details are not yet available in WEB-based manual.

I. Exterior of the hoods shall be constructed of cold rolled steel and shall have the component parts screwed together to allow the removal of the end panels, front end facia pieces, top facia panel, and air foil strips to allow replacement due to damage or to afford access to the plumbing lines and fixtures. Spacers or reinforcements shall be welded to their main parts. All welding shall be completed and the component parts bonderized and painted on both exterior and interior surfaces prior to assembly on the hood. All parts shall be of heavy gauges and have adequate strength for the extremes of operation to which a fume hood may be subjected and the entire structure shall be rigid and strong. The unit shall have its own frame and the exterior metal parts shall not be hung on the liner.

J. All surfaces exposed in the interior of the hood shall be fiberglass reinforced polyester, 3/16" to 1/4" thick.

K. Hoods shall be equipped with a removable baffle at the rear of the hood with non-adjustable openings at top and bottom and open down both sides to allow the flow of air through the hood to compensate for type of gases, apparatus or heat source used in the hoods. The baffle shall be free-floating design and removable to allow for cleaning and decontamination of the area behind the baffle and shall be held in place with stainless steel nuts.

L. A thermal formed, highly chemical resistant, plastic, belled entry cone with female socket for duct attachment shall be provided at top rear of liner. This device shall contain a condensate collection ring at liner roof level with drain capability.

M. The hood facia panels and the end of the hoods shall be punched to receive four remote controlled service fixtures at each side of the hood. Holes not used for specified fixtures shall have removal plug buttons which can be removed for later addition to service fixtures.

N. Head exterior panels shall be no less than 18 gauge steel, except that top front panel shall be 16 gauge, and air foil member 12 gauge.

.02 Auxiliary Air Hoods

A. Auxiliary air hoods shall be constructed the same as general purpose constant volume hoods. Provisions shall be made for the introduction by a separate blower furnished under the Heating and Ventilating contract. Auxiliary air shall be introduced into a plenum dampered by movement of the sash to accomplish the following results and shall be generally as shown schematically on the drawings. The amount of auxiliary air introduced to the hood shall not exceed 50% of the total required for exhaust.

B. When the sash is open more than 18 inches, all the auxiliary air shall enter the sash face through horizontal and vertical grill around the exterior face of the door in a peripheral direction and mix with the room air entering the hood at a capture efficiency of no less than 85 percent. When the sash is closed, the auxiliary air shall pass into the hood through a bypass at the upper front interior of the hood but shall be unobstructed by any dampering from leaving the hood plenum through the auxiliary air fan system. When the sash is down, some room air shall enter the hood through the bypass discharge grill and the balance under the one-inch high sash airfoil. Exhaust volume and hood static resistance shall be approximately the same with sash in any position.

C. The add-air system shall be an integral part of the hood as supplied from the factory and not a separate part added on at the project site.

.03 Isotope Hoods

Professional Note: The construction and performance specification for isotope hoods is the same as for General Purpose Constant Volume Hoods, with the following changes which shall be inserted where applicable, also refer to Paragraph 13B.5:

A. Surfaces exposed in the interior of the hood shall be type 304 stainless steel. The stainless steel, except the work top, shall be 16 gauge with a #2B finish. The work top shall be 14 gauge stainless with a #4 satin finish and is to be made in the form of a watertight pan, 1/2" deep, with a retaining ledge across the front edge. It shall be reinforced with a 10 gauge steel channel at the front and adequate reinforcement at the enter and rear to support a maximum uniform loading of 200 pounds per square foot. The joints of the liner shall be welded continuously and ground smooth. All corners shall be coved with a smooth radius. Interior shall be crevice free.

B. The entire stainless steel hood interior shall be reinforced with angles and plug-hats to provide a completely rigid assembly and shall be welded together to form a self-supporting hood assembly.

C. The collar for the exhaust duct attachment shall be of the same size as the exhaust duct and shall be butt welded to the duct.

.04 Perchloric Acid Hoods

A. Perchloric fume hoods are to be of the same basic construction and to meet the same test requirements as conventional fume hoods specified by the University with exceptions as hereinafter specified.

B. The hood interior shall be free of all crevices and corners. Vertical intersecting corners shall form a 1/2 inch radius cove. The lining shall be type 316-L stainless steel of 14 gauge thickness. All seams shall be butt welded, ground smooth and polished to a maximum surface roughness of 20 microinches RMS as measured by a Brush Surface Analyzer or a Profilometer. The lining shall be watertight. The work surface shall be dished 1/2 inch and shall have an integral trough at the rear to collect wash-down water and to serve as a sink.

C. A full-length perforated spray pipe or a series of nozzles, located behind the top baffle, shall be provided. The spray pipe, fittings, nozzles and supports shall be 316-L stainless steel.

D. All baffles, supports and components in contact with perchloric acid fumes shall be constructed of 316-L stainless steel.

E. The collar for the exhaust duct attachment shall be of the same size as the exhaust duct and shall be butt welded to the duct.

F. Accessories shall include five (5) remove controlled fixtures (two (2) gas, one (1) cold water, one (1) hood wash down water, one (1) duct wash down water), four (4) 120 volt AC and two (2) 208 volt AC electric outlets, blower switch with pilot light (of suitable rating to operate the exhaust fan). A face velocity, air flow monitor audio/visual alarm system shall be provided.

G. All fan components in contact with the perchloric acid fumes shall be 316 stainless steel or Type I, unplasticized PVC. A stainless steel or PVC nozzle system shall be installed in the exhaust duct to wash down the fan and duct work.

.05 Fume Hood Testing

A. Fume hoods shall be tested for air flow characteristics at the factory in the presence of designated representatives of the Professional and University. The hoods tested shall be those of each type first assembled, and all hoods shall be modified as may be deemed necessary as a result of the tests. The test room shall provide all equipment and test facilities, including variable calibrated, hood exhaust air, room make-up air, and auxiliary air. Air quantities shall be set to reproduce those shown on the Heating and Ventilating drawings for compliance testing, although demonstration tests at other cfm valves may be called for to observe hood flexibility. General purpose and constant volume fume hoods shall have a minimum face velocity of 100 feet per minute. Perchloric and Isotope fume hoods shall have a minimum face velocity of 125 feet per minute.

B. Test Procedures

1. Check construction details, materials, finish, sash operation, etc. Adjust hood exhaust quantity. Adjust room inlet air quantity. Adjust auxiliary inlet air quantity (where applicable).

(NOTE: Hood should exhaust slightly more air than that which is supplied to the room to maintain negative pressure in the room.)

Hood to be operated with sash full open, at 0", and 24" open.

2. Instrumentation and Apparatus Required for Hood Test:

a. "Alnor" Thermo-Anemometer with probe, scale graduated to read from 0-350 FPM maximum, or equivalent.

NOTE: Instrument shall have factory tested and recalibrated no longer than six months prior to the date of the test.

b. One (1) to two (2) gallon pan type container with pan sides not over 4" high.

c. Four (4) to five (5) pounds of dry ice.

d. Four (4) ounce bottle of Titanium Tetrachloride.

e. Ten (10) to twenty (20) cotton-tipped swab sticks.

f. Roll of masking tape.

3. Face velocity - Average face velocity equals exhaust cfm divided by sq. ft. sash opening. Face velocities taken at nine (9) points shall not vary by more than plus or minus 10 percent from average velocity.

4. Procedure:

   a. Make a complete traverse of the hood face with a cotton swab dipped in titanium tetrachloride to demonstrate that a positive flow of air is maintained into the hood over the entire hood face. No reverse air flows or dead air spaces will be permitted.

   b. Paint a strip of titanium tetrachloride along each end and across the working surface of the hood in a line parallel with the hood face and six (6) inches back into the hood to demonstrate that no back flows of air exist at these points. The flow of smoke shall be directly to the rear of the hood without swirling turbulence or reverse flows.

   c. Hold a cotton-tipped stick that has been immersed in titantium tetrachloride at the hood room air inlet and raise the hood sash slowly. Observe that the automatic air bypass is open when sash is in 0" to 6" position and closed when sash is open 8" or more.

   d. A smoke bomb (one minute size) shall be discharged within the hood area to show the exhaust capability of the hood and its design efficiency. No reverse air flows will be permitted. Place lighted bomb in the hood area and move it to various places, checking end panels and working surface to verify that no reverse air flows exist at any point. Lower the sash to closed position to verify that a sufficient air volume is flowing through the hood working area to carry away fumes from a massive fume source. Immediately after the smoke bomb stops discharging smoke, the hood area should be purged of smoke.

e. Place a pan of dry ice in hot water in the hood and observe flow of the heavy, white vapors generated. The flow of fumes shall be carried away to the back of the hood. No reverse flows of fumes along the work surface toward the front of the hood shall occur.

f. With the sash open, walk past the hood and observe action of the heavy fumes produced by the dry ice in hot water. Fumes should not gather at front edge of working surface of the hood but should sweep readily toward the rear lower baffle opening.

5. For Auxiliary Air Hoods, add the following tests:

a. A smoke bomb (one minute size) shall be discharged into the auxiliary air duct ahead of the blower and the flow of auxiliary air down the front of the hood shall be observed. At least 85 percent of the auxiliary air shall be drawn into the hood along with the room air.

b. With sash closed, check for room air being drawn into hood through bypass and under sash air foil.

c. With dry ice in hood, stop exhaust fan with auxiliary air fan operating and with sash closed. Check for any expulsion of fumes into room caused by hood positive pressure. Repeat with sash open.

C. Evaluation of Hood Tests

The purpose of the foregoing tests is to demonstrate that fumes do not escape from the hood under simulated operating conditions. If any fumes did escape during the test, <u>corrective measures must be taken prior to approval of the hood</u>. After design modifications have been made, the entire test is to be repeated until satisfactory performance is attained.

.06 <u>Hood Adjustment and Balancing</u>

A. After hoods are fabricated, delivered, and installed in the building and prior to the use of the hoods by operating personnel, it shall be the responsibility of the hood supplier to perform final adjustments on hood adjustable baffles, to measure hood face velocities and make recommendations to the Professional should deficiencies be found in the performance of any hoods manufactured by the supplier.

B. The expenses incurred by the inspection and adjustments of hood dampers shall be borne by the hood supplier who will promptly execute this work upon request by the Professional and the University.

.07 Hood Maintenance Instructions

A. Maintenance instructions for the hoods shall be provided by the hood supplier in the form of a printed, permanent metal plate affixed to each hood in an easily-readable position.

B. The plate shall be approximately 5" x 6" and shall list preventive maintenance procedures, appropriate cleaning materials for exposed metal surfaces, and other recommendations or precautionary measures for proper maintenance of the fume hood structure and parts.

.08 Manufacturer's Recommended Safety Procedures

For the benefit of operating personnel, the hood supplier shall provide a separate, printed, permanent, metal plate, approximately 5" x 6" with cautionary operating suggestions, including at least the following:

A. Maximum sash opening of 24" for safer working conditions.

B. Check of hood exhaust for proper functioning before use of the hood.

C. Avoidance of unnecessary exposure of personnel to fumes inside hood.

D. Safe limits and confines for placement of work inside hood.

E. Proper location of hot plates inside hood and compensatory measures to combat excessive heat loads.

F. Establish maximum heat loads inside hoods for safe operation and maximum temperature operating limit of glass in hood sash.

G. Most desirable sash location for safest hood operation.

H. Avoidance of overloading hood with equipment/apparatus and blocking air flow.

I. Corrective measures after spillage inside hood.

J. Instructions regarding day-to-day storage of corrosive or volatile materials inside hood.

K. Avoidance of certain explosive materials for which the hood is not designed.

.09 Differential Pressure Switch

A. Furnish and install a differential pressure switch to measure the differential pressure across each fume hood exhaust system. Should the system fail to exhaust as measured by the differential pressure switch, when the local switch is indexed to "Operational" or "Emergency," an audible alarm shall be sounded locally along with a red light. Provide a time delay to eliminate nuisance alarms at start-up. The audible alarm shall be provided with concealed volume adjustment. Furnish and install a local "silence" switch for the local alarm. The audible alarm and silence switch shall be mounted on or near the fume hood as indicated on the detail on the drawings.

DIVISION 12 – FURNISHINGS

12 00 00 FURNISHINGS

12 20 00 WINDOW TREATMENTS

12 21 00 Window Blinds

A. Venetian blinds shall be provided for all windows in occupied spaces unless otherwise directed by the University. See Division 13 20 10 – Classroom Design for further references to General Purpose Classroom document that includes information on window coverings.

B. Venetian blinds shall conform to the current specification of the Pennsylvania Department of General Services or as approved by the University.

C. Venetian blinds should be mounted so they do not interfere with the operation of the window. Also, there should be no less than three (3) inches of clearance between the blind and the glass when the blind is in the drawn-up position so that the window washers can clean this portion of glass without injuring their hands.

12 50 00 FURNITURE

12 52 00 Seating

.01 <u>Fixed Seating</u>

A. Single Support Pedestal Table and Chairs

See Division 13 20 10 – Classroom Design for further references to General Purpose Classroom document that includes information on seating.

B. Fixed Pedestal Chair with Folding Tablet Arm

1. General Description

This specification is for a one-piece contoured plastic seat with a folding tablet arm and a steel pedestal. It shall be attached to the floor and have an 18" seat height. See Division 13 20 10 – Classroom Design for further references to General Purpose Classroom document that includes information on seating.

2. Chair Top

The chair top shall be injection-molded one-piece plastic with sculptured contours for maximum comfort and attractive appearance. The shell shall be attached to the frame by means of molded pockets at the front underside of the seat area and at the sides of the back area of the one-piece shell. The die-formed steel mounting tubes shall be inserted into the molded pockets on the underside of the seat shell, and the steel back support tubes shall be inserted into the molded pockets on the side of the back area of the shell firmly attaching the one-piece shell to the frame. The shell shall be held in position at the rear bottom corners by means of two 3/16" rivets inserted through the shell and into the frame of the chair.

3. Folding Tablet-Arm and Armrest

The folding tablet-arm and armrest shall consist of a writing surface of thermosetting melamine laminate applied to a moisture-resistant high-density core, with plastic laminate backing, all in balanced construction. Edges shall be stained and sealed for appearance and full protection. Finished thickness shall be approximately 9/16". Work surface of tablet arm shall be not less than 220 square inches. The tablet arm shall be attached to a heavy steel flange-and-hinge mechanism on a tubular steel post which permits the folding of the tablet arm from the writing position to a vertical position, and then rotated rearward and downward for out-of-the-way storage. The armrest shall be securely attached to the upper end of the tablet arm support tube so that when the table arm is folded, the armrest shall be ready for use.

4. Pedestal

The chair pedestal shall consist of a rectangular steel floor flange welded to the lower end of the vertical member so as to permit proper attachment to the floor, level or inclined, as required. When required, this steel flange shall be welded to the rear side of the vertical member so as to permit the section to be mounted to the face of the riser. The upper end of the vertical members shall have a supporting surface for attachment of the chair top.

5. Metal Parts

All metal parts shall be phosphate-coated with an electrostatic spray finish in enamel. All metal coatings shall be baked for a period equivalent to

20 minutes at a temperature of 335°F. Adequacy of finish shall be determined by reasonable and relevant performance tests for resistance to flexing and abrasion.

C. Folding Tablet Arm Chair - Plastic or Upholstered

1. General Description

Beam-mounted chair system shall permanently attach to floor or riser face. Chair module shall include a self-rise seat to a 3/4 or "safety-fold" position with manual override to vertical or "passing-fold" position. Chair backs shall option of being sprung forward, sprung rearward, or locked in rear location. See Division 13 20 10 – Classroom Design for further references to General Purpose Classroom document that includes information on seating.

2. Chair Size

Seat height (at front center) shall be approximately 17-1/4"; back height approximately 30-1/2" above tread. Overall seat and back width shall be 16-3/8" minimum.

3. Chair Assembly

Chairs shall consist of plastic or padded upholstered seats and backs mounted on 7-gauge steel hinge arms, providing low-noise, self-rising action, with provision for securely mounting to 14-gauge steel tubular beam sized to support chairs and arms at appropriate intervals.

4. Back

Plastic backs shall be double-walled blow-molded polyethylene. Backs shall consist of a contoured, double-wall (nominally .125" thick), blow-molded polyethylene shell.

5. Seat

Plastic seats shall be double-walled blow-molded polyethylene. Seats shall consist of double-wall polyethylene shells.

6. Tablet Arms

Folding tablet arm shall measure approximately 150 square inches. Top shall consist of high-pressure melamine bonded to a high-density particle board core with phenolic backing sheet into one integral piece. Edges shall be stained Black. Arm shall be attached to a heavy steel flange, and shall incorporate a cast iron hinge block; shall fold up to vertical position, and rotate to the rear and down for out-of-the-way storage. A positive "up" and "down" stop shall be provided.

7. Mounting Pedestals

Chair beams shall be attached to the floor, or riser face, by an appropriate cast grey iron pedestal securely attached by use of lead shield-drive anchors. Pedestals shall be provided with a split clamp for securing to the beam in any appropriate location.

8. Materials

a. Molded Plastic - All seats and backs shall be made from high-density molded polyethylene 1/8" thick nominal.

b. Steel - All steel shall have smooth surfaces and be of sufficient gauge thickness to withstand strains from use and abuse.

c. Grey Iron - All grey iron shall be of quality and strength in accordance with American Society for Testing Materials Designation A-48 for Class 25 Grey Iron Castings.

9. Finish

a. Metal Parts - Parts shall be finished by immersion in alkyd urea enamel. Finish shall then be oven-baked to assure hard durable finish. Colors shall be as selected.

10. Installation

a. Seating Plan

The Contractor shall provide a complete seating plan developed from the Professional's blueprints or measurements of building. Seating plan is to show all chairs, chair sizes, and aisle widths. The Contractor must assume complete responsibility for accuracy of chair measurements shown by seating plan.

b. Method of Installation

Floor Type

Seating plan to be reproduced on floor, all dimensions checked against plan, and necessary adjustments made in layout for any discrepancies.

Chair standards to be attached to concrete floor by means of two 1/4" diameter expansion bolts set in holes 1-3/8" deep. Expansion bolts to be approved type of lead-drive anchor consisting of the following:

Bolt - 1/4" x 2" - special flat countersunk head with two fins under head and with hexagon nut. Bolt length to be of sufficient length and tensile strength to meet requirements.

Sleeve - 1/4" x 1/2" x 1" - lead (commercially known as 2% Antimony lead) with one end recessed to fit cone.

Cone - Cast hard metal or alternate formed steel.

Lock Washer

Flat Washer - To be slipped on bolt over standard to permanently secure nut. Installation Hardware - All installation hardware shall be zinc plated, or otherwise treated with a rust-resisting process.

D. Quality Control

To assume a high and satisfactory quality, the seat manufacturer shall fabricate, under his control, all parts composing the complete chairs, such as steel parts, plastic, etc. He shall also maintain thorough test and inspection procedures to assure a uniform high quality of all raw materials used, as well as the finished product. The seat manufacturer, upon request, shall provide documentation of procedures.

E. Previous Experience

The seat manufacturer shall provide with his submittal a list of not less than five installations of similar specifications installed by the bidder that have been in service for a period of at least two years.

.02 Movable Seating

See Division 13 20 10 – Classroom Design for further references to General Purpose Classroom document that includes information on movable seating.

12 56 00 Institutional Furniture

.01 Movable Instructor's Table

See Division 13 20 10 – Classroom Design for further references to General Purpose Classroom document that includes information on movable instructor tables.

DIVISION 13 – SPECIAL CONSTRUCTION

13 00 00 SPECIAL CONSTRUCTION

13 20 00 SPECIAL PURPOSE ROOMS

.01 Special Construction-Classroom Designs

13 20 10 Classroom Design

.01 General

For General Purpose Classroom and departmentally or college controlled classroom components and requirements refer to **CLASSROOM & TECHNOLOGY DESIGN & CONSTRUCTION MINIMUM REQUIREMENTS**, in the **Penn State Design and Construction Standards Page** available through:

http://www.opp.psu.edu/construction/standards/design_standards.cfm

and at:

http://clc.its.psu.edu/Classrooms/Design.

Both General Purpose Classrooms and department or college-controlled classrooms may have additional modifications or extras that exceed the minimum requirements.

13 20 15 Bookstore Design

.01 General

A. The following standards and guidelines shall apply to all new or renovated facilities constructed for Penn State Bookstores.

B. The right side of the facility, as one enters, should be considered to be the prime selling or retail area.

C. In no way should the following points of concern be restrictive to the design of the building. As with any project, points of concern, or the function, must have priority over the form. In attempting to acknowledge the responsibilities of the Penn State Stores and their ability to operate efficiently, effectively and professionally, these standards have been used and they have proven to be worthy guidelines.

.02 Common Areas

A. Walls, partitions, mechanical space, utility rooms, and/or bathrooms should represent approximately fourteen percent (14%) of the overall area.

.03 Storage and Office Area

A. Should represent approximately nineteen percent (19%) of the overall area.

.04 Windows

A. All windows should be at least 42" off the floor.

.05 Columns

A. Should be used as minimally as possible. When used, "I" beams would be preferred whereby electrical and other lines might be run within the column flanges. Also, when used, a 24 foot grid or span would be preferred.

.06 Floors

A. Generally, all floors will be poured at ground level and loading should be designed for 125 to 150 psf live load. Should there be any second level floors poured, they should be designed for 150 psf live load.

B. The manager's office area is usually raised 8" above the main floor. The partition between this office area and the main store area should have windows 34" above the floor of the office and 42" above the main floor.

.07 Floor Coverings

A. There are three specific areas of various floor coverings:

1. Generally, quarry tile is to be used in the foyers or entry areas. It is to be slip-resistant tile with abrasive material embedded in the surface, 1/2" thick, and similar or equal to American Olean Tile Company's "grey/pearl." It should comply with ANSI A137.1 American Standard specifications.

2. The second type of area would use Duravinyl Tiles. These areas would include traffic, check-out and textbook area. It is to be A2 Rock #DN19 by the American Tile Company, or equal.

3. Carpet is to be equal to Shaw Industries, Inc./ Philadelphia Carpet "Presentation 28"--ultra dense level Commercial Grade Class B. There are special "spec" sheets for this carpet available upon request.

B. Throughout, where display fixtures will not be against the walls, black vinyl cove base (6") will be used. This base should be installed after the floor tile, carpet and fixtures have been installed to insure a proper fit.

.08 Entrance Mats and/or Grilles

A. Each entry vestibule shall have a rigid type grille set in a mat frame in the entrance. The grille shall be set in a floor recess with a drain and be set on vinyl support cushions. It shall be set at a proper height to affect cleaning and allow clearance for all doors to swing over same.

.09 Drains

A. Standard floor drains and tapers thereto should be located in all utility or mechanical rooms, storage areas and, if practical, loading docks.

.10 Loading Docks

A. Each loading dock should have four (4) molded rubber heavy-duty bumpers and be equipped with load-leveling equipment.

.11 Ceiling Heights

A. Ceiling heights are preferred to be 10 feet with 9' 6" being considered the minimum. The office area may be 8" lower, considering it basically to be the same elevation as the retail area.

.12 Ceilings

A. Standard manufacturers acoustical ceiling in 2' x 4' or 2' x 2' panels, suspended or mounted in a proper manner, per FS-SS-S-118 or Type E as ASTM-E.795.

B. Panels should be of mineral composition with washable finish, fissured and perforated Pattern 8, such as Armstrong's World Minaboard "Tegular," Type A or B, lay-in; flame spread of 25 or less with a smoke developed of 50 or less; reflectance of at least 75%, such as White/LR-1, standard metal suspension as complies with ASTM-C635 requirements; in matching white.

.13 Lighting

A. It is desirable that general lighting be from metal halide, 2 x 4, 3 lamp units with approximately a 4" x 6" honeycomb lens.

B. Desired lumens would allow 65 foot candles at 32" off the floor throughout.

C. Special effect lighting as coordinated with the basic store design might very well call for 100 to 300 watt wall-washer, spot or flood lights about the retail area. These requirements will be provided by the University as required for incorporation with the lighting plans.

D. All general lighting should be located no closer than 36" from all perimeter walls within the retail area. This will allow for less conflict with possible wall fixture lighting following the design of the retail area.

E. A 6' 0" pigtail in "Greenfield," or equal, will be called for upon completion of the store design. Requirements for these will be located at random about the perimeter of the retail area. The pigtail will come from a junction box located 88" on center off the floor. Each should be on a separate circuit, switch controlled from the main panel. (Fixture lighting will be within the prescribed circuitry load usually single fluorescent lamps.)

F. Some ceiling lighting, or special units, may be used as night lights.

G. Emergency lighting should be installed within its own system and circuitry.

.14 Electrical

A. The main electrical concern will be the service that is required to each check-out and showcase as the store is designed.

B. Chase or duct should be run in the floor slab whereby it feeds to each location where electrical computer, telephone and security lines may be run. Each chase (4) should be separate with a combination of Walker Duct #2 an #4, or equal. The ducts should run from their location to the panel; one running out of one of the ways to the computer in the office before the panel. Each outlet should be isolated on or in a separate circuit. Each floor outlet fitting should be in a flush type unit. Six (6) circuits should be planned for these.

C. There will be standard outlets also required and a plan for same will be provided by the University as the facility is designed. Six (6) circuits should be planned for these.

D. In the receiving area, wire mold with an outlet every two feet will be required; 42" off the floor, flush in the wall. The location and length of this run will be provided by the University as the facility is designed. Two (2) circuits should be planned for these.

.15 Vents, Intakes and Exhausts

A. Generally, accommodations can be made in the wall fixturing for various vents.

B. When possible, however, consideration for the primary function of the facility should be given credence and such locations should be coordinated in the design of the facility, as well as the building.

C. Often such vents are better if located 7' 0" off the floor.

D. Baseboard heating around the perimeter of the retail area should not be considered.

.16 Controls

A. Controls have to be located within the proper means of the operation, but not at the expense of the main function.

1. Lighting controls

a. Generally, lighting should be switch controlled at the entry of the facility.

b. Additional controls should also be installed by rear entrances for the loading dock and in the receiving area.

c. Lighting of the wall fixtures (pigtails) should be located at the panel box.

2. Electrical power controls

    a. The switch controls for each floor outlet should be located at the panel box; and as well, those controlling the various outlets and other mechanical equipment.

3. HVAC system controls

    a. Controls for the HVAC should be located in the manager's office; however, thermostats should be located about the areas they govern.

    b. Attempts should be made to locate the thermostats so as not to conflict with the wall fixturing of the retail area. Within furred columns is preferable.

4. Electrical panel

    a. The main electrical panel should be located in the rear of the storage area, just off the retail area, for quick and easy access thereto.

5. Fire alarms and extinguishers

    a. Alarms and extinguishers are most certainly essential.

    b. They should be located where the function of the retail area does not restrict their easy access or conflict with being able to find same.

    c. Suggestions for their locations will be provided by the University as the interior design is developed with the basic electrical requirements.

.17 <u>Telephone and Computer Lines</u>

A. See Office of Telecommunications Minimum Wiring Standard.

.18 <u>Paint and Colors</u>

A. Painting is required and all aspects as to the proper preparation, prefinishes and the general application should prevail.

B. Basically, it is essential that all finishes match those existing at other bookstore facilities for the versatility of equipment and decor harmony throughout the Penn State system.

C. Colors which must be matched are as follows:

   1. Blue: To match Dark Blue, #91M25 by Westinghouse Micarta

   2. White: To match Frosty White, #1573-6 by Wilson Art

   3. Oak: To match Golden Oak, #7888-3 by Wilson Art

   4. Black: To match Pearl Black, #92M16 by Westinghouse Micarta

   5. Any and all suggested equals must have the approval of the Penn State Store management prior to use.

.19 Miscellaneous

A. Full glass doors at store entrance.

B. Handicap door hardware.

C. Security - Motron Detectors Door Contacts - These need conduit installed.

D. Electrical strip on each office wall and wall behind service counter.

E. Duplex receptacles every 48" @ 42" above floor in stockroom.

F. All receiving doors (outside/in) to be double or over head and from receiving to sales area minimum 42" opening.

G. Employee restroom in any individual Bookstore building must be equipped for handicapped.

H. Pitched roof with outside gutters preferred with conductors down to storm drain.

I. Floor drain in receiving area.

J. Outside water in individual Bookstore building.

K. Janitor closet with floor drain, hot and cold water fixtures with hose connections.

L. All Mechanical Room walls must extend to roof deck or slab for security.

M. Display window with shadow box and locked doors.

N. All door locks to be Medeco Brand.

O. Panic Hardware on all exterior doors.

P. Penn State Stores are designed to use Hermsdorf Fixtures Mfg. Co. of Manchester, NH

13 21 00 Radioisotope Laboratory Design

.01 General

A. A laboratory designed for the use of chemicals is suitable for most of the experiments at a university using radioactive material. Benchtops, shelving and sinks should have smooth impervious surfaces with a minimum of joints. Stainless steel is very suitable and may be required where chemicals are used that dissolve or react with organic coatings. Soapstone, wood and other porous material should not be used. However, trays and absorbent paper are required when using any significant quantity of radioactive material making it possible to work with even poor surfaces.

.02 Floors

A. Floors should also be impervious. Tile floors have joints that can collect contamination but have the advantage that contaminated sections can be easily removed and replaced. Epoxy finishes can also be provided that are smooth, impervious, long-wearing and repairable.

.03 Eating Area

A. One item that is often overlooked is the need for an eating area separate from the laboratory. In radioisotope laboratories food storage, food preparation, and eating or drinking are prohibited. Therefore, refrigerators and sinks in laboratories may not be used for storage, refrigeration of food, or washing eating utensils. The eating area must be an area separate from the laboratory; either a separate room or a partition from the rest of the laboratory. If offices are to be used for eating areas, sinks should be provided for food preparation. The study cubicles used inside some laboratories do not meet the requirements for a separate eating area.

.04 <u>Sinks</u>

A. Sink drains may be of any material compatible with the chemicals to be used. Sink traps should be readily removable for recovery of lost items and contamination checks. Glass plumbing should be protected against heavy objects, such as magnetic stirrers, that can fall through large distances in vertical pipes and break the glass pipe. Glass drain should also be protected from freezing and routed so that leakage goes into pipe chases and not through ceilings into laboratories and offices.

.05 <u>Fume Hoods</u>

A. It is the general policy at the University that radioisotope experiments be designed so that a hood is not needed to meet the requirements for concentration of airborne radioactive material. Hoods serve only as a backup in case of unanticipated release of radioactive material. Therefore, well designed chemical hoods are suitable for most radioisotope work.

B. Hoods should be designed for a face velocity of 100-500 feet per minute. Some hoods with separate makeup air systems may not meet the face velocity requirement but still give satisfactory performance if the collection efficiency for airborne material released in the hood is equivalent to that of a 100 fpm face velocity.

C. Hoods should be located away from doors, windows, heavy traffic areas and other sources of drafts that could cause backflow from the hood.

D. Sufficient makeup air is to be provided to the hood or room to allow for proper air flow. Blowers should be located as close to the exhaust end of the ducting as practicable. Duct velocity should be as high as possible to reduce duct contamination without creating a noise problem or requiring excessive energy to operate at a high pressure drop.

E. One exception to the above hood requirement is the design of hoods for radioiodination. Such hoods must meet the following additional requirements:

1. A linear face velocity of 125 fpm minimum, 150 fpm maximum with sash full open.

2. An activated carbon filter for radioiodine plus a prefilter to reduce dust loading of the activated carbon. The activated carbon filter should be designed for a minimum contact time of 0.25

second. Filters are to be of standard AEC design (24" x 24" cross-section, up to 12" deep) and interchangeable with HEPA filters.

3. Stainless steel interior for ease of decontamination.

4. A minimum width of 60 inches.

5. A manometer to indicate filter pressure drop mounted at the hood face.

6. A low-flowrate alarm. A direct reading manometer with pressure switches such as the Dwyer Photohelic gauge can serve as the manometer and flow-rate alarm.

.06 Animal Rooms

A. Rooms that meet the requirements for animal care can usually be used for in-vivo radioisotope experiments. The room should be large enough to accommodate extra waste containers and monitoring equipment during an experiment, typically about 25-50 square feet. If the experiment involves larger numbers of small animals or large animals it may be necessary to use anticontamination clothing and additional space for a change pad and clothing storage (50-100 square feet) is needed.

B. Walls and floors of animal rooms should be easily cleaned. A bare room with tile or epoxy floor and walls is recommended.

C. Furniture should be movable or easily washed in place.

D. At least one large, deep-bowl sink, preferably of stainless steel should be provided.

E. A hose bib with hot and cold mixing faucet is recommended for washing floor and walls.

.07 Miscellaneous

A. There should be sufficient walk in freezer space (20-40 square feet) available for extended storage of contaminated animal carcasses for radioactive decay. Laboratory space adjacent to the animal room is recommended for preparation of radiochemicals, and processing of samples. At least one table of sufficient size to handle the largest animal expected to be used should be provided for surgical procedures, implanting catheters, drawing blood samples, etc.

B. Each radioisotope laboratory should have at least one cabinet that can be locked for storage of radioisotopes. If refrigerated storage of radiochemicals is required, a refrigerator or freezer with a lock is required.

C. Specialized laboratories for the use of alpha-emitting radionuclides and high intensity gamma ray sources may require additional features such as a change area for work clothes, filtration of exhaust air and shielded storage space for radioisotopes.

DIVISION 14 – CONVEYING EQUIPMENT

14 00 00 CONVEYING EQUIPMENT

14 20 00 ELEVATORS

.01 General

A. Contact OPP Design Services for a base specification to include with the contact documents for each project.

B. The following criteria for installation of elevators on campus must be followed:

1. For two (2) floor structures, with a maximum rise of 14'0", use of a holeless hydraulic is preferred. In cases where heavy use is anticipated, a traction elevator should be considered.

2. For three (3) to five (5) six (6) floor structures, with a maximum rise of 60'0", use of a roped hydraulic is preferred. In cases where heavy use is anticipated, a geared traction elevator should be considered.

3. For all structures containing seven (7) or more floors, with a rise exceeding 60'0", use of a traction type elevator is preferred.

C. In no case shall a conventional hydraulic elevator be installed. This means any installation that requires the use of in-ground oil-filled components is strictly prohibited.

D. Three stage Telescopic holeless hydraulic elevators are prohibited.

E. In all cases, where hydraulic elevators are installed, car speed shall not exceed 150 feet per minute.

F. In all cases where geared traction elevators are installed, car speed shall not exceed 350 feet per minute.

G. The car capacity for any passenger elevator installed on campus will be a minimum of 2,500 lbs., with a maximum of 5,000 lbs. The maximum may be exceeded based on requirements for a special application, but must be reviewed by the University prior to its manufacture.

H. Elevators, when installed, must service all floors.

I. Elevator access to mechanical rooms shall be key-controlled only.

J. The manufacturer of the elevator shall have been in business fabricating elevator equipment for a minimum of fifteen (15) years. Elevators assembled by companies which do not manufacture 60% of the equipment supplied will not be acceptable. The installation contractor is required to provide the University with a listing of at least five (5) comparable installations completed within the last twelve (12) months.

K. Standby power is required for this installation.

L. 110v standby power is needed to feed alarm bell.

M. GAL Master gearless door operator is preferred as the University standard.

N. All push buttons are to be vandal resistant stainless steel with 100,000 hours life LED type indicators.

O. Gatekeeper 2000 Adams ICU 47 infrared car door protective device is the preferred University standard.

P. Shunt trip breakers are required if sprinklers are present in hoistway or machine room.

Q. The University requires that each elevator shall meet the requirements required under ASME A17.1-2000 including all addenda through 2002.

R. In no case shall Machine room less elevators (MRL) be installed.

S. Manufacturers: Subject to compliance with requirements, provide elevators by one of the following:

1. CEMCOLIFT, Inc. LGIS/Otis, Hatfield, PA (Basis of specification)
2. Port Elevator Inc, Williamsport, PA
3. Minnesota Elevator, Mankato MN
4. Canton Elevator, Massillon, OH
5. Vertical Express, Thyssen Krupp Elevator
6. University Design Services approved equal.

.02 Machine Room

A. The elevator machine room shall be adequately ventilated and accessed by means of an outwardly swung fire-rated door measuring at least 3'0" x 7'0". The door must be outfitted with a spring closer and lockable handset. Ambient room temperature to be maintained between 60° and 100° Fahrenheit.

B. Non-elevator related equipment or piping may not be run through this room.

C. The elevator mainline electrical disconnect and the machine room light switch must be located adjacent to the machine room door and arranged so they may be accessed without entering the room. Electrical main disconnect and 110v disconnect must both be fused.

D. Clearance shall be provided for all control panels and equipment cabinet doors to open at least 90°, and at least three (3) feet free of obstructions shall be provided on all sides of machinery.

E. The machine room must be equipped with a minimum of one (1) wall-mounted fire extinguisher.

.03 <u>Controls</u>

A. Single elevator installations shall be provided with simplex selective collective operation from a riser of hall push-button stations.

The registration of one or more car calls shall dispatch the car to the designated floor in the order in which the floors are reached by the car, irrespective of the sequence in which the calls were registered. The car shall also respond to registered hall calls in the same direction of travel. Car and hall calls shall be cancelled when answered.

When traveling in the up direction, the car shall stop at floors for which car calls or up hall calls have been registered. It shall not stop at floors where a down hall floor is in response to a registered car call, or unless the down hall call is at the highest floor for which any call has been registered. Likewise, a down-traveling car shall not stop at a floor where only an up hall call has been registered unless the stop for that floor is in response to a registered car call, or unless the up call is at the lowest floor for which any call has been registered.

B. Where two (2) elevators are installed side-by-side and intended to operate as a group, these installations shall be provided with duplex collective operation from a riser of hall push-button stations.

Elevators shall automatically travel to landings for which a call demand exists. Stops in response to calls that are registered at either the car or corridor push-button stations shall occur in the natural order of progression in which the floors are encountered, depending on the direction of car travel, and irrespective of the order in which calls are registered. Means shall also be provided to periodically review and modify strategies for corridor call assignment in order to improve traffic flow. Only one (1) elevator shall respond to a particular corridor call.

C. The controller shall be of the electro-magnetic type. Relays shall be of the enclosed "ice-cube" type unit. It shall be designed to control starting, stopping and prevent damage to the motor from overload or excess current and to automatically cutoff the power supply and bring the car to rest in the event of the operation of any of the safety devices. The controller shall be enclosed in a sheet metal cabinet with louvered door, designed for floor or wall mounting.

   If a microprocessor controller is used it shall meet the following criteria:

   A non-proprietary microprocessor-based controller shall be provided, including necessary starting switches together with all, relays, switches, and solid-state components required for operation. Microprocessor shall be a "off the shelf" industrial type programmable controller utilizing ladder logic such as Allen Bradley, Square D, Omron, etc. Microprocessor shall have opto-isolated inputs and outputs. Shall be isolated with Dry Relay contacts. Controller shall have all diagnostic and trouble shooting readouts located directly on the unit. Controller shall have the ability to be replaced by a unit of different model or manufacturer without the necessity of replacing any other relater items (door operators, selectors, buttons etc.). Installer shall supply a hard copy printout of all ladder logic programming as well as one additional set of programmed chipsets.

D. Motor Control:

   1. Variable frequency AC type motor controllers shall

      a. Limit total harmonic distortion of regenerated power to 5% Per IEEE 519.

      b. Provide means for absorbing regenerated power when elevator system is operating on standby power.

   2. Soft Start motor control shall be of the Wye delta, closed transition type. Refer to PSU VFD specification.

E. The University requires that each elevator shall be controlled Recalled by the fire alarm system as required by the Firefighters service requirements outlined in ASME A17.1-2000 with the 2002 addendum. I Pennsylvania Department of Labor and Industry Title 34, Section 7.33, "Operation of Elevators under Fire or Other Emergency Conditions."

F. Controller manufacturers: Subject to compliance with requirements. Provide controller by one of the following manufacturers:

1. Motion Control Engineering
2. Elevator Systems Inc.
3. Virginia Controls
4. University design professional approved equal

G. Remote Monitoring System: Provide and install an interactive system to monitor and manage the elevator equipment. The data collection, data storage and real-time monitoring portion of the system shall be based on Microsoft Windows, and able to run on Windows XP or later operating system compatible with University systems. The system shall be network-based and be capable of interfacing with all makes and types of elevator control systems. System shall be compatible with any manufacturer, type or age of elevator. The system shall collect data via serial data connections. The system shall be capable of operating on any TCPIP based network system. The addition of unlimited monitoring terminals shall be possible on the network. Monitoring terminals shall operate “peer to peer” without a single server, and the failure of a single network device shall not affect the operation of the rest of the system. The system shall provide multiple banks, including multiple buildings, on a single monitoring terminal screen. The system shall be capable of simultaneous monitoring of at least one hundred elevator units on a single monitoring station. The system shall be capable of real-time display of all monitored status points on all monitored equipment. Fault and event notification screens and audible alarms shall be immediately displayed on selected monitoring station, based on Boolean logical combinations of the monitored status points. Different vault and event tables shall be defined on a per-bank basis. The system shall collect and store all status, fault and event information for later reporting and analysis. The system shall provide statistical analysis of hall call response times, traffic patterns, fault conditions, service logs and security usage in graphical and tabular format. The system shall maintain a record of every status point change occurring on the monitored equipment, and provide the ability to replay these events in a simulation at a later time in real-time, slow speed, single step, reverse, or fast forward. These features may be revised as the requirements of the building change. Some of these interactive controls may include but are not limited to: security floor lockouts, entering car and hall calls, Fireman’s return service & lobby recall. System shall have the capability to interconnect and monitor all elevator emergency phones. The system shall display and record the following information for each monitored unit: (The following is intended as a guideline - connections to each status point mentioned on every control system may be impractical. Serial data links may include many more points.)

1. Individual car status - expandable menus - including but are not limited to: Direction of travel, Independent service, Fire service, Position of elevator, Door status (open, opening, closing, closed), Door dwell time, Power on/off, Door detector, Safety circuit, Door zone, Stop switch, Alarm button, Registered Car Calls

2. Data ports – Provide one serial data port for connection of an onsite laptop computer, and one cat5 port for future network connection for each elevator controller.

3. Network wiring to be provided by the University.

4. Laptop computer - One laptop computer is to be provided by the elevator contractor for each elevator.

.04 Elevator Car

A. Clear inside car dimensions shall be determined by door configuration provided.

   1. Where side-opening doors are installed, the minimum dimensions are 5'8" wide x 4'6" deep.

   2. Where center-opening doors are installed, the minimum dimensions are 7'0" wide x 4'6" deep.

B. Minimum door openings shall be 3'6" wide x 7'0" high.

C. Provide stainless steel protective pad hooks in all cars; in freight and combination passenger/freight cars, provide one (1) set of quilted fire-retardant pads.

D. Provide stainless steel handrails on back and sides of cab, which are thru-bolted to the elevator cab shell.

E. The car roof hatch shall be removable by thumb screws from the top of the car only.

F. Provide a ceiling-mounted, two-speed exhaust fan with automatic shutoff during equipment nonuse. The fan shall be controlled from the car control panel via a three (3) position key switch.

G. Provide a cartop-operating device including service light and switch, and a mobile control for inspection and servicing, as well as one (1) 120-volt, 20-amp A/C duplex receptacle.

H. Lighting

1. The car lighting shall be T8 lamps per 26 00 00, connected to a normal/emergency lighting circuit.

2. Dimmable fluorescent lighting above luminous ceiling to provide 19 foot candles minimum at the floor level. Provide the following equipment:

   a. Luminaire – Strip light with Lutron "ECO 10 TVE" (0-10 volt electronic dimming ballast), having a range of 100% to 10% light output or approved equal by Advance, Sylvania or Universal.

   b. Lamp – GE High Lumen, Philips Advantage, or Sylvania XPS.

   c. Controls - Wattstopper power pack #FS-PP and sensor #FS-305. Fabricate a 2"x2" "L" stainless steel bracket and integrate the sensor into the center of the ceiling grid. Mount the power pack within one luminaire and connect to the sensor and each ballast. Power pack shall provide a 0-10 volt output to the ballasts so that when no occupancy has been detected for 5 minutes, lighting shall dim to 10% output or a minimum of 5 footcandles at the floor, whichever is higher. Power pack shall fail in the "On" position.

I. Provide cab wall protective pads.

J. Elevator two-way communications system: Provide and install a two-way communication system to comply with ANSI ASME A17.1 section 2.27. Furnish and install a "hands free" two-way conversation analog telephone system between the elevator car and a location in the building that is readily accessible by emergency personnel. An additional means of communication must be provided between the elevator and University Police Services headquarters. A separate means of two-way conversation must be provided in the elevator machine room for communication to the elevator car.

1. Provide and install an analog ADA compliant, hands-free indoor emergency phone, flush mounted with AUX inputs/outputs and voice location identifier.

   a. Suggested manufacturer and model: Talk-A-Phone; ETP-100EBV"AUX" phone.

2. Furnish and install a two-way conversation telephone system between the elevator car and a location in the "egress floor level lobby" that is easily accessible by emergency personnel. The telephone must be housed in a secure telephone enclosure outfitted with a

"Best" key core and lock set. The contractor must coordinate the enclosure with the Penn State Physical Plant's lock shop. The cabinet must protrude no more than 4" into the pedestrian corridor as per ICC/ANSI A117.1-1998.

a. Suggested box manufacturer and model:
Guardian; WRT series gray telephone enclosure

b. Suggested telephone manufacturer and model:
Talk-A-Phone; 68429 analog panel mount phone.

3. Furnish and install a two-way conversation telephone system between the elevator car and the elevator machine room.

a. Suggested manufacturer and model:
Talk-A-Phone; 68429 analog panel mount phone.

4. Additional components: provide and install all necessary peripheral components to complete the elevator two-way communications system.

a. Provide and install an analog telephone line consolidator in the elevator machine room that will connect the analog phone lines going to the elevator car, "lobby" phone, and the "machine room" phone.

b. Suggested manufacturer and model:
Talk-A-Phone "EC-8 with PSU CHIP" 8 Channel Consolidator

c. Raceways between elevator machine room controller and "Lobby" phone location: (Existing Construction):
All raceways installed between the elevator controller and lobby phone shall be concealed within the existing building construction where possible. Walls shall be "fished" using a ¾" flexible metal conduit from ceiling to the location of the phone device box. Raceways above ceilings shall be concealed where suspended ceilings are existing, using ¾" EMT conduit with compression type fittings. Where concealment above ceilings is not possible, raceways shall be surface mounted and painted to match surrounding finishes, routed in a neat inconspicuous manner. Raceways shall be installed in accordance with the 2002 National Electrical Code.

d. Telephone device boxes:
Contractor shall coordinate final device box requirements with University based on phone type selected. Contractor shall provide a single gang metal device box flush mounted in wall at a height as directed by the University at final location of the lobby phone.

e. Contractor to provides and install CAT 5e communication line to connect all three points of contact to the machine room installed consolidator on to the specified telecommunication source in the building (room 110).

f. Contractor to provide normal emergency power to the elevator machine room mounted telephone consolidator.

General Contractor to activate, program, and test the system, to ensure proper operation and communication to Penn State Police Services.

g. Contractor to coordinate and request telecommunications service and necessary telephone numbers to the telecommunication source in the building. Telecommunications request form must be submitted to the Penn State Physical Plant Financial Support Services Office ROOM 118.

K. Ascending car over-speed and unintended car movement protection: A device shall be provided to prevent the car from striking the hoistway overhead structure. Electrical power failure or mechanically operated switch failure shall not render the device inoperative. Once actuated, the device shall remain actuated until manually reset. A device shall be provided to prevent unintended car movement away from the landing when the hoistway door and car door are open.

.05 Signal Fixtures

A. All hall and car control stations shall comply with the latest regulations of federal ADA law, Pennsylvania Department of Labor and Industry, and ASME A17.1 provisions for the handicapped. Install 'Best' key switches for each floor button for floor cutouts and independent service.

B. All car operating panels shall contain, at a minimum, the following:

1. A call button for each floor served.

2. “Door Open" and "Door Close" buttons.

3. Three (3) position key switches/locks, all floors, except the main landing. The positions shall be lock on, lock off, spring-loaded "call" switch position which automatically returns to "lock off".

4. "Alarm" button, connected to a normal and separate emergency circuit.

5. "Elevator Stop" key switch.

6. Car position indicator.

7. Hands-free two-way in-car communications system.

8. Three (3) position firefighter key-operated switch, all cancel button, and illuminated/visual/audible signal system.

9. Phase II firefighter's service operating procedures engraved directly to the care-operating panel face.

10. A locked service cabinet containing the key switches required to operate and maintain the elevator, including, but not limited to:

    a. Light switch
    b. Independent service key switch
    c. Fan switch
    d. Duplex GFI receptacle

11. The operating panel shall be a surface-mounted type with heavy-duty hinges and secured with tamperproof screws.

12. Control panel faceplates shall have factory-provided knock-outs to receive a "Best" system cylinder and core. All key switches shall match the building lock cylinders ("Best" system).

C. Hall call stations shall provide a single button at each terminal floor and two (2) button units at all intermediate floors. Faceplates should be engraved, “In case of fire, Do not use elevator.” Mounted with tamper-proof screws. Install a firefighter key switch at the main egress floor station. Engrave Phase I firefighter's service operating procedures directly to call station faceplates.

D. Cab lanterns shall provide a visual and audible signal mounted in the face of the return post on each side of the car with concealed fastenings. The lens shall project a minimum of 1/4" and shall be of solid Plexiglas. Car lanterns shall indicate the direction of the car when doors are 3/4 open. The unit shall sound once for the "up" direction and twice for the "down" direction.

.06 Pit & Shaft

A. Guide rails shall be the “T” type and able to support the weight of the car.

B. Car guides shall be of the roller type.

C. The pit ladders, pit light switch and emergency stop button shall be so arranged so that all can be reached before entering the shaft. All devices shall be higher than 24 inches above finished floor. An additional stop switch, accessible from the pit floor, may need installed in the pit if the bottom floor accessible stop switch cannot be reached from the pit floor.

D. Provide a sump pit, within the elevator pit, covered with a steel plate flush with the floor.

E. Provide pump in sump pit. Pump shall have oil sensing device and audible alarm mounted outside the pit/shaft. Pump alarm shall be monitored by CCS. Provide Stancor “Oil-Minder” SE50 or similar.

F. Paint the pit floor and sump with a “battleship gray” waterproof paint, made for the purpose.

G. GFI convenience outlet shall be installed in the pit, higher than 24 inches above finished floor.

H. Provide a dedicated 20A normal circuit for GFI receptacle(s) and required lighting fixtures. Provide two (2) 2-lamp 48 inch shallow depth (4 inches or less. Williams #91, or similar) lensed T8 luminaires in the pit and one at each landing above the pit. Mount luminaires vertically in a corner, except pit luminaires may be horizontal. Mount all devices higher than 24 inches AFF in the pit.

I. Traveling cable must have 2 shielded pairs of 20AWG 0.5 mm2 and 1 coax line RG6/U to support telecommunication requirements. Traveling cable is to contain at least 10% spare wires.

J. When modernizing or installing traction elevators, any time bearings for a dead shaft on a sheave are to be replaced, use double tapered roller bearings that can support all axial and radial loads imposed on that sheave.

K. Any time a drive sheave is replaced for an overhead traction elevator, replace the deflector sheave and bearings also.

.07 Guarantee and Warranties

A. Warrant the equipment installed under these guidelines against defects in material and workmanship, and correct any defects not due to ordinary wear and tear or improper use of car, which may develop within one (1) year from the date the elevator is completed and placed in permanent operation and accepted by the Owner.

B. The warranty shall be written and issued at the completion of each unit prior to final payment.

C. During the one (1) year warranty period, the elevator installer shall provide emergency service on a twenty-four (24) hour basis. The assigned mechanic shall respond within four (4) hours of any service call.

D. A first response of a qualified University elevator technician, of four (4) hours or less, shall not void the warranty.

E. The installer shall replace all hydraulic cylinder seals six months after the elevator is placed in service.

.08 Permits, Testing, and Inspections

A. File necessary drawings for approval of all authorities having jurisdiction, obtain and pay all required fees for permits and inspections, etc., which may be required for the execution of this work. Copies of all permits shall be forwarded to the Owner.

B. Obtain, arrange, and/or pay for any necessary tests and inspections.

C. Furnish all test instruments and materials required at the time of final inspection. The inspection outlines in the ASME A17.2 Inspector's Manual (latest edition) will be followed.

D. After-hours testing of systems, such as emergency generators or fire service, shall be conducted at no extra cost to the Owner.

.09 Maintenance and Instruction Material

A. The University performs all maintenance with its own staff and must have three (3) complete sets of all electrical schematics, including printed circuit boards, mechanical drawings, service manuals, and diagnostic/service tools that are available to elevator manufacturer's installers and service personnel. These shall include all control wiring, shall show all solid-state circuits, and shall identify all electric and electronic components as originally installed including all field adjuster notes. The name of the manufacturer and the manufacturer's catalog number shall be provided for all components not manufactured by the elevator installer.

B. A complete parts list, recommended lubricants and a recommended spare parts list shall also be provided.

C. The University must receive all required drawings, manuals and parts lists before final payment is made to the Contractor. The fact that a drawing, manual or maintenance tool may contain proprietary information is not considered by the University to be sufficient reason for refusing to furnish any drawing or manual.

D. Furnish one (1) complete set of all diagnostic tools, equipment, and documentation required for the complete maintenance of all aspects of the control and dispatch, including a “mechanic’s” service tool. Any diagnostic system shall be an integral part of the controller and provide user-friendly interaction between the serviceman and the controls. The Documentation shall include a description of component function, a hard copy of all as-built schematics, a hard copy set of source codes utilized in developing any control software, and an electronic copy of all source codes utilized. Any and all such systems shall be free from secret codes and decaying circuits that must be periodically reprogrammed by the manufacturer.

E. Drawings are to be laminated both sides for protection. Prints to be hole punched and bound with metal two metal rings in flip chart fashion. Contractor to provide a metal cabinet to store the as built drawings in the elevator machine room. Cabinet to be Grainger #1ufc1 36”x 30”x 18”.

.10 Hydraulic Oil

A. Hydraulic system oil shall be a bio-based oil that is EPA 1311 compliant as well as the more strict Pennsylvania DEP compliance for spills and soil clean up. The oil must be considered a non-toxic waste if land disposed.

B. Acceptable manufactuer: Agri Tech Brands, a Division of Bunge Oils Corporation.

C. Other manufacturers will be considered by the University. Submit independent testing showing compliance with paragraph ‘A’ to Design Engineering Services four (4) weeks prior to project bid date.

DIVISION 21 – FIRE SUPPRESSION

21 00 00 FIRE SUPPRESSION

21 00 10 Owner General Requirements and Design Intent

.01 General

A. Provide fire protection systems unless exempted by the local code, and FM Global. A fire standpipe protection for buildings during construction should be referenced to the requirements of the code, the fire department and FM Global.

B. If requested by the University, an approved automatic fire-suppression system shall be provided where solvents and/or explosive materials are stored or used, and in kitchens over appliances which produce grease-laden vapors.

C. Professional Note: The University has established specific quality assurance requirements for installation of sprinkler systems protecting areas of 1,000 square feet or greater in new buildings and renovation projects. Consult with the University Project Manager for the proper terminology to be incorporated in the project specifications.

.02 Design

A. Design systems in accordance with the local code, the requirements of the local fire department, BOCA, applicable NFPA Standards and FM Global standards.

B. For a few isolated sprinklers, use 100 square feet, ordinary hazard pipe schedule with sprinklers at least 50° above ambient temperature. A fire department pumper connection is not required. Water flow and valve tamper should be monitored. Inspector's test is required at the end of the system, along with a drain close to the control valve.

.03 Submittals and Approvals

A. All devices and equipment installed in the systems must be approved and listed by Underwriters Laboratories and Factory Mutual Research Corp., (FMRC).

B. Early contact with FM Global by the Professional is suggested.

C. Prior to final approvals by the University, the Professional shall submit plans and specifications to FM Global for their approval and submit these approvals to the University.

D. Final Contractor's shop drawings and specifications shall be submitted to FM Global for their approval prior to submittal to the Professional for his approval.

.04 Hydrant Tests

A. All projects involving street-pressure sprinkler systems, street-pressure fire standpipe systems or fire pumps require hydrant tests on the mains in all streets that could be used to feed the building. Since these tests take time to get, they should be initiated as soon as possible at the start of a project. Have a hydrant flow test made by the local water department, water company, or FM Global. At University Park, flow data is available from the Utilities System Engineer. Any flow data obtained from University utilities or local water departments should be confirmed with FM Global before being used for design basis.

.05 Utilities (Refer to Division 33 00 00)

.06 Mechanical Rooms

A. Comply with Space Planning for Engineered Building System requirements in Introduction.

B. Coordinate and comply with other applicable mechanical room requirements as described in 23 00 01.06.

.07 Janitor Rooms

A. Janitor rooms are not accessible to maintenance employees. Therefore, mechanical equipment, valves, electric panels, thermostats, etc. are not to be placed in these rooms.

21 01 00 Operation and Maintenance of Fire Suppression

.01 Coordinate and comply with all applicable general Operation and Maintenance requirements as described in 23 01 00, adapted to all Fire Suppression systems, equipment and controls.

21 05 00 Common Work Results for Fire Suppression

21 05 01 Fire Suppression General Requirements

.01 Painting

A. See Division 09 90 00.

.02 Access Panels

A. Access panels are required in each situation where items requiring maintenance are located above a concealed ceiling.

B. Use screwdriver actuated locks.

C. Access panel sizes shall be suitable for application.

D. Access panel locations shall be indicated on contract drawings.

E. Access panels are not required in lay-in ceilings, but identify appropriate tile with color button, cleated through, located on the adjacent ceiling grid. Use color code of principal service.

.03 Motors and Drives

A. Motors

1. All motors over 1/2 hp shall be ball bearing unless otherwise noted.

2. All ball bearing motors shall be equipped with lubricating type bearings, and provided with one (1) grease fitting per bearing and one (1) removable plug per bearing in the bottom of the grease sump to provide for flushing and pressure relief when lubricating. Motors shall be permanently marked that bearings are lubricating type bearings. Where motor grease fittings are not accessible, extend 1/8" steel or copper tubing from fitting to an accessible location.

3. Motors 3/4 hp and larger to be three phase, 60 hertz.

4. Motors smaller than 3/4 hp to be single phase, 60 hertz, 120V and shall have built in thermal protection.

5. All motors above 1 hp shall be the low loss - high efficiency type. Motors shall be tested in accordance with NEMA standard MG1 1.536 and name plate shall indicate the index letter.

6. All 3-phase motors larger than 5 hp shall have power factor correction capacitors as recommended by the manufacturer.

7. Motor inrush current must not create a voltage sag in excess of 3 percent without specific University approval.

8. A voltage sag report shall be completed by the Professional on selected projects as determined by the University. Report shall include backup calculations and expected building voltage sag when motor or motors in question are started.

9. The University has experienced widespread premature motor shaft bearing failures due to fluting from electrical arcing on motors equipped with Variable Frequency Drives. The Design Engineer must specify appropriate technologies and/or include provisions in the system design to prevent electrical fluting induced premature bearing failure from occurring.

B. Drives

1. All belt driven equipment shall include properly selected adjustable sheaves and matched V belts, all rated for 150% of motor horsepower. Proper expanded metal guards should be provided for safety protection and to allow for proper ventilation for cool operation of belts. <u>Solid sheaves</u> and <u>band belts</u> shall be used to minimize vibration in multiple V-belt driven equipment.

2. Motor grease fittings shall be extended so belt guards do not need to be removed.

3. All adjustable sheaves shall be replaced with suitable fixed sheaves prior to final acceptance by the University.

.04 <u>Pressure Gages and Thermometers</u>

A. Gages for general use shall be "Quality" type as manufactured by Marsh Instrument Company or equal. Gages shall have a 4 1/2 inch diameter dial. In main mechanical room, Contractor shall provide 6" diameter gages for water and air. Gages shall be calibrated for static head. All gages shall be equipped with shutoff valves and snubbers.

B. The scale on gages and thermometers shall be read to twice the operating pressure or temperature. The Professional shall specify gage and thermometer ranges.

.05 Pipe Hangers and Supports

A. Provide an adequate pipe suspension system in accordance with the current version of the International Mechanical Code, recognized engineering practices, using standard, commercially accepted pipe hangers and accessories. The use of pipe hooks, chains, or perforated iron for pipe supports will not be accepted.

B. Pipe suspension systems for fire suppression systems shall be designed and installed in conformance with applicable sections of NFPA. See Division 21 00 10.01 – 21 00 10.04 for additional requirements.

C. Contractor shall submit Data sheets for approval on all pipe hanger items prior to installation.

D. All piping shall be arranged to maintain the required pitch and provided for proper expansion and contraction.

E. No holes are to be drilled or burned in structural building steel for hanger rod supports.

F. Vertical runs of pipe shall be supported with riser clamps made specifically for pipe or for tubing.

G. Where concentrated loads of valves and fittings occur, closer spacing may be necessary. Hangers must be installed not more than 12 inches from each change in direction of pipes.

H. All hangers for piping shall be provided with a means of vertical adjustment. If adjustment is not incorporated in the hangers, use turnbuckles.

I. Provide piping suspension systems with vibration isolation capability as required. For vibration isolation requirements of piping suspension systems, refer to Paragraph 15A.13.

J. Copper clamps and hangers shall be used on copper piping.

.06 Sound and Vibration Control

A. Coordinate and comply with all applicable requirements as described in section 23 05 01.05.

.07 Mechanical Identification

A. Coordinate and comply with all applicable requirements as described in section 23 05 01.06.

21 07 00 Fire Suppression Systems Insulation

.01 Insulation

A. Typically fire suppression systems are not insulated. For any exceptions that might be encountered, comply with insulation requirements defined in Div 23.

21 09 00 Instrumentation and Control for Fire-Suppression Systems

.01 Building Fire Alarm Panel

A. The building fire alarm panel described in Division 28 shall receive the alarms from fire pumps (current failure and pump running), water-flow alarm devices, alarm valves, CO_2 systems, Halon systems, tamper switches, and others as required for the project.

21 10 00 WATER-BASED FIRE-SUPPRESSION SYSTEMS

21 11 00 Facility Fire-Suppression Water-Service Piping

.01 Piping

A. Piping shall be pitched and valves installed to facilitate complete drainage of the system.

B. All piping run within the building shall be run concealed in the finished portions of building in pipe spaces, ceilings or furred chases and exposed only in mechanical rooms and where shown on the drawings.

C. No pipe shall pass in front of or interfere with any openings, door or window. Head room in front of openings and doors shall in no case be less than the top of the opening.

D. Piping shall not pass exposed through electrical rooms or be erected over any switchboard or other electrical gear.

E. Sleeves:

1. All pipes passing through wall or floor construction shall be fitted with sleeves. Each sleeve shall extend through its respective floor, wall or partition and shall be cut flush with each surface unless otherwise specified. Sleeves shall be two pipe sizes larger than the pipe when un-insulated and of sufficient size to allow for the insulation without binding. Floor sleeves in mechanical rooms shall extend 4 inches above finished floor, all other spaces minimum one inch above finished floor.

2. Sleeves in bearing walls, masonry walls, masonry partitions, and floors shall be standard weight steel pipe finished with smooth edges. For other than masonry partitions, through suspended ceilings and for concealed vertical piping, sleeves shall be No. 22 USG galvanized steel.

3. Where pipes pass through waterproofed floor or walls, design of sleeves shall be such that waterproofing can be flashed into and around the sleeves.

4. Sleeves through exterior walls below grade shall have the space between pipes and sleeves caulked watertight.

5. Install one-piece chrome-plated escutcheon plates with set screw at sleeves for all pipes exposed in finished areas.

6. The annular space between sleeves and pipe shall be filled with fiberglass insulation and caulked in non-fire rated situations.

7. Where pipes pass through fire-rated floors, walls, or partitions, the use of a UL approved system for through penetrations is required. The annular space around the pipes shall be packed with mineral wool or other noncombustible material and sealed at each exposed edge to maintain the rating of the system in accordance with the through penetration sealant manufacturer's recommendations.

F. System and Equipment Drains:

1. All piping shall be arranged to completely drain the system. Drain locations shall be located at all system low points.

2. Where sectionalizing valves are installed, a drain shall be installed on downstream side of valve to drain that section of the system.

3. All system and equipment drains are to be piped to a floor drain.

.04 Automatic Source and Siamese Connections

A. Water systems should be supplied from at least one automatic source and siamese connections.

B. Verify siamese location and size requirements with the University Fire Protection Engineer and local fire department.

C. Siamese connections are two-way 2 1/2" National Standard thread fire connection with individual clappers at University Park.

D. Where street pressure is sufficient (as determined from hydrant flow test), use it as the automatic source for the system or the lowest zone.

E. Where everyday static pressures in the system exceeds allowable limits, the system should be zoned to comply with the maximum pressures allowed by code and/or NFPA.

F. Where street pressure is insufficient, the automatic source should be automatic fire pumps.

G. If a fire pump is required, a jockey pump is also needed. Cross connections (potable and nonpotable water supplies) should be avoided.

.05 Pressure-Reducing Valves

A. At levels where a pressure of over 170 psi could occur during a fire, provide approved pressure-reducing valves (pilot-operated type) on the standpipe and/or sprinkler connections.

B. Provide fixed orifice-type pressure reducers on 1 1/2" valves where required, and adjustable orifice-type on 2 1/2" valves where required. The use of approved pressure-reducing hose valves on NFPA design systems increases the allowable zone height from 275 to 400 feet.

.06 Piping (Inside Building)

A. Piping inside building shall conform to NFPA Standard 13 or 14. If pressure is over 175, use extra heavy fittings.

B. Piping subject to alternate wetting and drying, such as drain piping, test piping, siamese connections between siamese and check valve shall be galvanized, Schedule 40, and properly sloped to completely drain.

C. Avoid running wet pipe systems in areas exposed to freezing. If it is absolutely necessary to run piping in a freezing area, it should be on a dry pipe system or anti-freeze system.

D. Dry pipe system shall use galvanized pipe, Schedule 40, properly sloped to completely drain.

E. Wet pipe systems may be Schedule 10, black steel, except maintain Schedule 40 from water entrance main to backflow preventer.

.07 Valves

A. Valves should be IBBM or cast steel as follows:

1. Fire pump discharge check valves should be spring type when the lift to the top of the system is 35 feet or more.

2. Control valves 6 inches and larger, except at fire pumps should be provided with by pass valves.

21 12 00 Fire-Suppression Standpipes

.01 Standpipe Systems

A. Standpipe systems should be wet pipe systems.

B. Provide control valves on all risers and branches with three or more hose outlets.

C. Riser control valves shall be located with the approval of the University.

D. Branch piping for hose valve shall be minimum 2 1/2" for maximum of 20 feet.

E. Provide 2 1/2" hose valves with 1 1/2" threaded reducers with chained caps.

F. Hose valves shall be located so that all floor areas are within 100 feet of hose using a 30-foot hose system.

G. Provide water flow alarm devices and tamper switches.

H. Installation shall comply with latest edition of NFPA 14 "Installation of Standpipe and Hose Systems" and FM Global Data Sheet 4-4N.

.02 Combination Systems

A. In combination systems, sprinkler connections may be taken from the fire standpipe risers.

B. Standpipe work (plumbing) will terminate in a control valve with tamper switch for the sprinkler connection.

C. For alterations (adding sprinklers) in existing buildings, insure the minimum acceptable water supply for the combined system.

21 13 00 Fire-Suppression Sprinkler Systems

.01 Sprinklers

A. Sprinklers should be wet pipe systems except where project requirements dictate otherwise.

B. Sprinkler work should include water-flow alarm devices and tamper switches.

C. Provide tamper switches on control valves when required by code, by the underwriters, or the owner.

D. Sprinkler systems shall be in accordance with NFPA 13 and FM Global Data Sheet 2-8N. Sprinkler systems shall have:

1. An automatic water supply of adequate pressure, capacity, and reliability.

2. Definite maximum protection area per sprinkler and indicated on the drawings with a schedule of location, type, coverage and sprinkler size.

3. Location of sprinklers coordinated with all other trades to provide clearances and obtain suitable sensitivity. Close proximity to possible interferences shall be indicated on the drawings.

4. Coordinate with architect's reflected ceiling plan.

E. Either hydraulic calculations or pipe schedule tables shall be utilized for system design. All calculations, flow data, and other design criteria shall be submitted for review.

21 20 00 FIRE-EXTINGUISHING SYSTEMS

.01 Fire Extinguishers (See Division 10 40 00.01)

.02 Other Fire-Extinguishing Systems

A. The use of other types of fire-extinguishing systems shall be discussed with the University.

B. Water Spray Fixed Systems shall conform to NFPA 15 and FM Global Data Sheets 4-1N.

C. Dry Chemical Extinguishing Systems shall conform to NFPA 17 and FM Global Data Sheets 4-10.

D. Wet Chemical Extinguishing Systems shall conform to NFPA 17A.

21 21 00 Carbon-Dioxide Fire-Extinguishing Systems

.01 Carbon Dioxide Fire-Extinguishing Systems

21 24 00 Dry-Chemical Fire-Extinguishing Systems

.01 Halon Fire-Extinguishing Systems

A. Conform to NFPA 12A.

B. Contact the University for required Halon system reserve, tests required, and FM Global approvals of design. Tests shall be conducted during unoccupied periods. Tests shall be witnessed by OPP, FM Global, and EH&S and be scheduled two weeks in advance.

21 30 00 FIRE PUMPS

.01 General Requirements

A. Size fire pumps as required by the local code, the fire chief or fire marshal, or FM Global, whichever is greater.

1. For motor-driven pumps, select 3,500 rpm rather than 1,750 rpm whenever a choice is available.

2. Refer to NFPA Standard 20 for data on fire pumps.

B. Fire-pump heads shall include the pressure required at the top of the system, total system height, system friction, and the minimum available suction pressure.

C. When no emergency generators are being provided in the project, check with the underwriters if an engine drive is required for the fire pump. The University prefers diesel engine drive.

D. Provide fire pumps with a valved cross-connection between discharge and suction (inside the control valves) for testing.

   1. 3 inch for 500 gpm pump.
   2. 4 inch for 750 gpm and larger pump.

E. Fire pump relief valves, when required, should be piped back into the suction.

F. Check the local code NFPA Standard 20, and FM Global Data Sheets 3-7N for the fire pump room construction.

DIVISION 22 – PLUMBING

22 00 00 PLUMBING

22 00 10 Owner General Requirements and Design Intent

.01 Utilities (Refer to Division 33)

.02 Mechanical Rooms

A. Comply with Space Planning for Engineered Building System requirements in Introduction.

B. Coordinate and comply with other applicable mechanical room requirements as described in 23 00 01.06.

.03 Janitor Rooms

A. Coordinate and comply with all applicable Janitor room requirements as described in 23 00 01.06.

.04 Laboratory Equipment

A. Where laboratory equipment is shown on the general construction drawings, this equipment shall also be shown on the plumbing drawings. The equipment shall bear the same identification numbers on all sets of drawings.

B. The same equipment schedule shall appear on the architectural, and plumbing drawings. This schedule shall give the equipment identification number, equipment description, services required, and the Contractor who is to furnish and install this equipment.

22 01 00 Operation and Maintenance of Plumbing

Coordinate and comply with all applicable Operation and Maintenance requirements as described in 23 01.00.

22 05 00 Common Work Results for Plumbing

22 05 01 Plumbing General Requirements

.01 Painting

A. See Division 9.

.02 Access Panels

A. Access panels are required in each situation where items requiring maintenance are located above a concealed ceiling.

B. Use screwdriver actuated locks.

C. Access panel sizes shall be suitable for application.

D. Access panel locations shall be indicated on contract drawings.

E. Access panels are not required in lay-in ceilings, but identify appropriate tile with color button, cleated through, located on the adjacent ceiling grid. Use color code of principal service.

.03 Piping

A. Piping shall be pitched and valves installed to facilitate complete drainage of the system.

B. All piping run within the building shall be run concealed in the finished portions of building in pipe spaces, ceilings or furred chases and exposed only in mechanical rooms and where shown on the drawings.

C. No pipe shall pass in front of or interfere with any openings, door or window. Head room in front of openings and doors shall in no case be less than the top of the opening.

D. Piping shall not pass exposed through electrical rooms or be erected over any switchboard or other electrical gear.

E. Pipe sizes shall be indicated on the plans at each change in direction and at all branch take off locations.

F. Provide 2-inch clearance between insulated piping and other obstructions.

G. Unions:

1. No union shall be placed in a location which will be inaccessible.

2. Unions shall be installed adjacent to all equipment for repair and replacement.

H. Electrolysis Control:

1. Electrolysis control between dissimilar materials shall be achieved through the use of dielectric nipples and a non-dielectric union. Dielectric unions shall be avoided whenever possible.

I. Sleeves:

1. All pipes passing through wall or floor construction shall be fitted with sleeves. Each sleeve shall extend through its respective floor, wall or partition and shall be cut flush with each surface unless otherwise specified. Sleeves shall be two pipe sizes larger than the pipe when un-insulated and of sufficient size to allow for the insulation without binding. Floor sleeves in mechanical rooms shall extend 4 inches above finished floor, all other spaces minimum one inch above finished floor.

2. Sleeves in bearing walls, masonry walls, masonry partitions, and floors shall be standard weight steel pipe finished with smooth edges. For other than masonry partitions, through suspended ceilings and for concealed vertical piping, sleeves shall be No. 22 USG galvanized steel.

3. Where pipes pass through waterproofed floor or walls, design of sleeves shall be such that waterproofing can be flashed into and around the sleeves.

4. Sleeves through exterior walls below grade shall have the space between pipes and sleeves caulked watertight.

5. Install one-piece chrome-plated escutcheon plates with set screw at sleeves for all pipes exposed in finished areas.

6. The annular space between sleeves and pipe shall be filled with fiberglass insulation and caulked in non-fire rated situations.

7. Where pipes pass through fire-rated floors, walls, or partitions, the use of a UL approved system for through penetrations is required. The annular space around the pipes shall be packed with

mineral wool or other noncombustible material and sealed at each exposed edge to maintain the rating of the system in accordance with the through penetration sealant manufacturer's recommendations.

J. System and Equipment Drains:

1. All piping shall be arranged to completely drain the system. Drain locations shall be located at all system low points.

2. Where sectionalizing valves are installed, a drain shall be installed on downstream side of valve to drain that section of the system.

3. All cooling tower drains and overflow are to be piped to sanitary system (not onto roof).

4. All system and equipment drains are to be piped to a floor drain.

K. Welding:

1. All welding shall be done in accordance with the AWS.

2. All boiler, pressure vessel, and gas piping welding must be done by certified welders as required by applicable codes.

3. All welding must be done with portable welding machines.

L. Pressure Tests:

1. All piping must be tested prior to receiving insulation.

2. Test pressures shall be minimum 1 1/2 times system operating pressure or as specified by the Professional.

3. Pressure tests must be witnessed and acknowledged in writing by a University representative.

.04 Pipe Specialties (Refer to Division 23)

.05 Piping Systems Disinfection

A. Before being placed into service, all new water lines, except those used exclusively as fire lines, shall be disinfected in accordance with AWWA standards. Final connections to existing water lines shall not be made until this procedure is completed satisfactorily.

B. The University shall be notified at least two weeks in advance of the date and time that the disinfection is to begin. The University shall witness the process.

.06 Piping Systems Testing

A. Hydrostatic Testing

1. All piping must be tested prior to receiving insulation.

2. Prior to filling the systems, all joints and potential leak sources shall be painted with a water-power blue line caulk mixture and allowed to dry.

3. During the test each joint shall be visually inspected.

4. Test pressures shall be specified by the Professional.

5. The University shall be notified at least two weeks in advance of the date and time that the hydrostatic testing is to begin. The University shall witness the testing.

.08 Pressure Gages and Thermometers

A. Gages for general use shall be "Quality" type as manufactured by Marsh Instrument Company or equal. Gages shall have a 4 1/2 inch diameter dial. In main mechanical room, HVAC Contractor shall provide 6" diameter gages for all steam pressures and pumped condensate pressure. The Plumbing Contractor shall provide similar gages for water and air. Gages shall be calibrated for static head. All gages shall be equipped with shutoff valves and snubbers.

B. Siphons shall be used with all steam gages. Also, all gages shall have gage cocks or valves suitable for the pressure involved.

C. Thermometers for general use shall be stem type with an adjustable bracket. Thermometers shall be organic liquid filled (red) in lieu of mercury filled.

D. The scale on gages and thermometers shall be read to twice the operating pressure or temperature. The Professional shall specify gage and thermometer ranges.

.09 Valves

A. General

1. All valves on any one project shall be the product of one manufacturer.

2. Valves shall be right handed. Balancing valves shall be a type that can be used for shut-off without disturbing balancing point setting.

3. Where possible, valves shall be installed with valve bonnet in an upright position to prevent deterioration or corrosion of bonnet and packing.

4. Valve body materials shall be compatible with piping system materials.

5. In all applications, use ball valves for shut-off purposes and globe valves for throttling purposes in the bypass line.

6. Gate valves may be used for shut-off purposes in large line sizes.

7. Ball valves equipped with “characterizing discs” may be used for throttling purposes in lieu of globe valves.

B. Pump Valves

1. All constant speed circulating pumps shall included a separate shut off valve, balancing valve, and check valve. Triple duty valves are not allowed.

2. Triple duty valves or balancing valves shall not be used on pumps equipped with variable speed drives.

C. Shutoff Valves

1. Isolation shutoff valves shall be installed at each piece of equipment, terminal unit, and each branch takeoff to facilitate shutdown for repair. Positive shutoff balancing valves with memory may satisfy this requirement at terminal units.

D. Balancing Valves

1. Balancing valves shall be installed in all 3-way control valve bypass lines and at all flow meters.

2. Gate valves shall be limited to shutoff service only. Gate valves shall <u>not</u> be used in a throttling application. Globe valves or ball valves shall be used.

E. Check Valves

1. Where check valves are required, check valves shall be installed on the equipment side of all shutoff valves to facilitate servicing the check valve.

F. Drain Valves

1. Drain valves shall be a minimum of 3/4" with hose end connection.

.10 <u>Pipe Hangers And Supports</u>

A. Provide an adequate pipe suspension system in accordance with the current version of the International Mechanical Code, recognized engineering practices, using standard, commercially accepted pipe hangers and accessories. The use of pipe hooks, chains, or perforated iron for pipe supports will not be accepted.

B. Contractor shall submit Data sheets for approval on all pipe hanger items prior to installation.

C. All piping shall be arranged to maintain the required pitch and provided for proper expansion and contraction.

D. No holes are to be drilled or burned in structural building steel for hanger rod supports.

E. Vertical runs of pipe shall be supported with riser clamps made specifically for pipe or for tubing.

F. Where concentrated loads of valves and fittings occur, closer spacing may be necessary. Hangers must be installed not more than 12 inches from each change in direction of pipes.

G. All hangers for piping shall be provided with a means of vertical adjustment. If adjustment is not incorporated in the hangers, use turnbuckles.

H. Provide piping suspension systems with vibration isolation capability as required. For vibration isolation requirements of piping suspension systems, refer to Sound and Vibration Control below.

I. Copper clamps and hangers shall be used on copper piping.

.11 Sound and Vibration Control

A. Coordinate and comply with all applicable requirements as described in section 23 05 01.05.

.12 Mechanical Identification

A. Coordinate and comply with all applicable requirements as described in section 23 05 01.06.

22 07 00 Plumbing Insulation

.01 Insulation

A. Fire Hazard Ratings

1. All insulation shall have composite (insulation jacket and adhesive used to adhere the jacket to the insulation) Fire and Smoke Hazard ratings as tested under procedure ASTM E-84, NFPA 225 and UL 723 not exceeding:

a. Flame Spread 25

b. Smoke Developed 50

2. Accessories such as adhesives, mastics, cements, and cloth for fittings shall have the same component ratings as listed above.

3. Paper laminate jackets shall be permanently fire and smoke resistant. Chemicals used for treating paper in jacket laminates shall not be water soluble and shall be unaffected by water and humidity. The only exceptions to the above are flexible foamed plastic insulation.

B. General

1. All pipe insulation shall be continuous through walls, partitions, ceiling openings and sleeves where fire and smoke ratings permit such penetration.

2. Where pipes pass through fire-rated floors, walls, or partitions, the use of a UL approved system for through penetrations is required. The annular space around the pipes shall be packed with mineral wool or other noncombustible material and sealed at each exposed edge to maintain the rating of the system in accordance with the through penetration sealant manufacturer's recommendations.

3. Insulation on all cold surfaces must be applied with a continuous, unbroken vapor seal. Hangers, supports, anchors, etc., that are secured directly to cold surfaces must be adequately insulated and vapor sealed to prevent condensation.

4. Edges of vapor barrier insulation at valve stems, instrument wells, unions and other raw edges must be adequately sealed to prevent moisture from penetrating the insulation.

C. Insulation Protection Shields:

1. Insulation protection shields fabricated from galvanized steel shall be installed at all pipe hangers and supports. Shields shall span an arc of 180°.

2. Provide shield lengths and thicknesses as outlined in the latest version of the International Mechanical Code or MSS-SP69.

3. Rigid cellular glass insulation, capable of resisting the crushing effect of the hydraulically loaded piping, shall be placed under each shield. Jacketing material shall be wrapped around rigid insulation and adjacent top and butt sections to maintain the jacketing continuity.

4. An 18 gauge stainless steel shield shall be installed on insulated piping located on the roof. The shield shall be a minimum length of 36 inches and field located to prevent damage to the insulation while walking over the piping.

D. Pipe Insulation

1. Insulation systems shall conform to requirements in ASHRAE Standard 90.1-1999.

2. In general, refrigerant piping systems shall be insulated with elastomeric pipe insulation.

3. In general, all other piping systems shall be insulated with fiberglass piping insulation with an all-service jacket. Fittings, flanges, and valves shall be insulated with fiberglass inserts and premolded polyvinyl jackets.

4. Special insulation protection shall be considered for areas subject to abuse, moisture, etc. (i.e. outside, wash down areas).

E. Equipment Insulation

1. In general, equipment shall be insulated with elastomeric or mineral fiber insulation. All

equipment handling a medium below ambient temperature shall be additionally provided with a sealed vapor barrier.

2. The following equipment must be insulated to the fullest extent possible. Removable “Hot Cap” insulation must be provided for those items that will require insulation removal for periodic maintenance or inspection. This includes many of the items listed below.

    a. Steam

        1) Valves, strainers, pressure reducing valves, pressure relief valves, traps, and condensate receivers/pumps, flash tanks, heat exchangers

    b. Hot water

        1) Valves, strainers, pumps, expansion tanks, air eliminators, storage tanks.

    c. Chilled water

        1) Pumps, valves, heat exchangers.

22 10 00 PLUMBING PIPING AND PUMPS

22 11 00 Facility Water Distribution

.01 Plumbing Piping

A. Soil, Waste and Vent Piping

1. The University prefers neoprene vent roof flashings with stainless steel clamps.

2. Cast Iron

    a. Cast iron soil pipe and fittings above grade shall be service weight (SV) No-Hub. Pipe and fittings shall conform to ASTM A-888. No-Hub couplings shall conform to ASTM C 1277.

    b. Cast iron soil pipe and fittings below grade shall be extra heavy weight Hub and Spigot. Pipe and fittings shall conform to ASTM A-74. Neoprene gaskets shall conform to ASTM C 564.

c. Cast iron soil pipe shall be supported every five (5) feet and at every joint. Hangers shall also be installed at branch locations and where lines change directions. Stacks and risers shall be supported at the base by concrete piers and by riser clamps at floor level.

d. Any Soil piping installed below a building’s floor slab shall be cast iron.

e. All drain piping downstream of equipment having the potential to discharge hot steam condensate to drain in the event of a malfunction must be cast iron.

3. PVC or CPVC

a. Piping shall have fused joints and DWV fittings.

4. Acid Waste Lines - Underfloor/Underground to First Manhole

a. Acid-resistant underground waste and vent lines shall be cast iron hub and spigot alloyed with approximately 14 percent silicon and shall conform to ASTM D651-48. Piping shall be Durion or equal.

b. Joints in acid-resisting pipe shall be made with caulking lead conforming to ASTM B-29.

c. The need for acid neutralizing sumps will be determined by code requirements. The University prefers not to use them, piping the acid waste directly from the building to the nearest sanitary manhole.

5. Acid Waste Lines Within the Building

a. Acid waste lines shall be Schedule 40, flame retardant, polypropylene with mechanical joints similar to Enfield Lab-Line.

B. Water Piping

1. Copper Tubing

a. Copper water tubing shall be Type L hard drawn.

b. Joints shall be made with no lead solder or the Viega Pro-Press system.

c. The use of cross-linked polyethylene (PEX) tubing is not allowed for domestic water piping.

C. Compressed Air Piping

1. Compressed air piping above grade shall be Schedule 40, galvanized steel conforming to ASTM A-53. Fittings shall be malleable screwed end.

D. Vacuum Piping

1. Vacuum piping shall be Schedule 40 black steel with malleable screwed fittings, or Type L, hard drawn copper tubing with no-lead solder joints.

E. Natural Gas Piping

1. Natural gas piping shall be Schedule 40 black steel with malleable screwed fittings.

F. High Purity Water Piping

1. High purity water piping, fittings, and valves shall be polypropylene with fused joints.

.02 Plumbing Specialties

A. Valves

1. A gate valve, angle valve, or compression stop shall be placed immediately below each plumbing fixture on each hot and cold supply so that service can be readily shut off for maintenance.

2. All branch lines in the water supply piping shall be fitted with ball valves. Ball valves shall also be used for sectionalizing the water distribution system.

3. Ball valves must be equipped with valve stem extensions long enough to allow the handle to easily clear the pipe insulation that will be installed over the valve.

4. All valves shall open with a counterclockwise motion.

All exposed valves in finished areas shall be plated.

B. Water Hammer Arresters

1. Water hammer arresters shall be installed on cold water piping to toilet rooms where flush valves are used. The arresters shall be the hydro-pneumatic type and shall be sized properly to control the water hammer.

2. Any quick-acting automatic valves supplying equipment shall also have water hammer arrestors installed.

C. Gages

1. Provide pressure gages on each side of water meters, water filters, and PRV's.

D. Backflow Preventers

1. Acceptable manufacturer: Conbraco (no substitutions)

.04 Pumps

A. Constant Pressure Pumps

1. Where constant pressure pumps are required on the potable water system, they shall be installed in duplicate and be similar to Peerless Pumps' VFD (Variable Frequency Drive) Pumping System.

B. All pumps shall have bronze impellers.

22 12 00 Facility Potable-Water Storage Tanks

.01 Storage Tanks

A. All pressurized tanks shall be ASME stamped.

B. Provide access manholes for inspection.

22 30 00 PLUMBING EQUIPMENT

.01 Domestic Water Heaters

A. Sizing

1. Caution should be exercised in sizing electric hot water generators located at the Commonwealth Campuses. The general trend has been for designers to oversize these units.

2. The University prefers to use design criteria obtained from the Werden-Spielvogel report prepared for the Edison Electric Institute Commercial Building Water Heating Research Project (EEI Project RP61).

B. Hot Water Generators

1. The shell of the generator shall be designed for a working pressure of 150 psig and shall bear the ASME code for Unfired Pressure Vessels and shall meet the Commonwealth of Pennsylvania, Department of Labor and Industry regulations.
2. All heating coils of hot water generators installed at the University Park Campus shall be constructed of cupronickel alloy containing 10 percent nickel.

3. Hot water generators shall be a tank type, similar to Patterson Kelley Compact 400 Series. The unit shall be complete with ASME rated pressure and temperature relief valves, inlet and outlet thermometers, pressure gauges upstream and downstream of the control valve, bronze body circulating pump, condensate strainer, float and thermostatic trap, control valve, vacuum breaker, steam line strainer and all auxiliaries necessary to compose a complete working unit. Where campus compressed air is available, the steam control valve shall be air-loaded (if air is available).

4. Instantaneous hot water generators shall not be used unless approved in advance by the University. When approved, instantaneous hot water generators shall contain a cupronickel coil (10 percent nickel) and all the auxiliaries required for the above type generator with the exception of the circulating pump. The steam control valve on instantaneous hot water generators shall be air-loaded (if air is available) or steam actuated. Self-contained valves are not accepted. Instantaneous hot water generators shall be similar to Leslie Constantemp or Aerco.

22 31 00 Domestic Water Softeners

.01 <u>Water Conditioners</u>

A. The need for water softening shall be determined on an individual project basis.

B. Units shall be similar to Kisco.

22 32 00 Domestic Water Filtration Equipment

.01 Water Filtration Devices

A. The need for water filtration shall be determined on an individual project basis.

B. Units shall be similar to Kumo.

22 40 00 PLUMBING FIXTURES

.01 Plumbing Fixtures

A. Floor Drains

1. Floor drains in mechanical rooms, laundries, promenades, terraces, and similar locations shall have perforated sediment bucket with integral auxiliary drainage rim so designed that grate cannot be set in place until bucket is in position.

2. Sterilizers and autoclaves shall have a fixed air gap between the equipment and the sewer.

3. Floor drains located in areas where air is introduced into air-handling equipment shall have their traps equipped with a trap seal primer valve with automatic vacuum breaker.

4. Floor drains located above the ground floor shall be equipped with clamping collars and shall be flashed with 24" x 24", 6-lb. sheet lead.

5. A floor drain shall be provided to serve each emergency shower. Drain shall be located directly below shower head. Floor shall slope toward drain.

B. Water Closets

1. Toilets shall be wall hung, vitreous china, elongated bowl, siphon jet action, 1 1/2 inches top spud similar to American Standard Afwall.

2. Toilet seats shall be open front, no cover, white with stainless steel check hinge similar to Church.

3. Closet fittings and carrier shall be similar to Josam's Unitron series.

4. Flush valves shall be Sloan or Zurn water saver type. Shall not exceed 1.6 gal./flush.

C. Urinals

1. Urinals shall be high efficiency wall hung, vitreous china, washout with 3.4-inch top spud and 2-inch outlet. Urinals shall be similar to Zurn #Z5798 “The Pint”.

2. Carriers shall be complete with fixture bolts, bearing plate, adjustable extension, steel pipe uprights, cantilever foot bases and chrome plated trim. Carriers shall be similar to Josam Unitron series.

3. Flush valves shall be sensor operated, hard wired, and consume no more than 1/8 gallon per flush. Acceptable manufacturers:.Sloan,Zurn, or Toto.

4. The use of waterless urinals is prohibited.

D. Lavatories

1. Lavatory carriers shall be of the institutional type with support plate, bearing plate steel uprights and block bases for supporting lavatory fixture with concealed hangers. Carriers shall be similar to Josam C-356.

2. Lavatory supply and waste lines should enter the wall to allow for easier cleaning and better sanitation.

3. Provide at least one hose bibb on the hot and cold water supply under one lavatory in each restroom.

4. Lavatory faucets shall be of the self closing type with the closing time of operation adjustable up to fifteen (15) seconds. They shall contain interchangeable operating units and shall be of one (1) manufacturer. Units shall close with the pressure of the water. All units shall be vandal-proof and all operating parts in contact with water shall be Monel metal, including a stamped Monel metal seat.

5. Faucet shall be Chicago faucet No. 406 (or No. 747 if a pop-up waste is specified with faucet), center-set lavatory fitting. Equivalent units, as manufactured by Moehn Faucet Division, Cole Valve Company, or American Standard, are acceptable.

E. Showers

1. Single Showers

a. Shower heads shall be self-cleaning and of the vandal-proof type solidly attached to shower stall. Use water saver type.

b. Shower controls shall be Powers Series 420, thermostatically controlled, with chrome plated metal levers.

c. Showers shall have Dole flow controls, limiting water flow to two (2) gallons per minute, installed between the mixing valve and the shower head.

2. Gang Showers

a. Shower heads and controls shall be the same as for single showers.

b. Piping supplies shall be from below the floor.

c. Units shall be manufactured by Bradley or equal.

F. Antifreeze Hose Bibs

1. Antifreeze hose bibs are needed adjacent to all building entrances for the purpose of washing down walks and entrances.

2. Hose bibbs shall be key type.

G. Service Sinks

1. Service sinks shall be similar to Stonite Precast Terrazzo Mop Service Basins as manufactured by Stonite Products Company. Service basins shall be 24 inches square with three (3) inch wide and twelve (12) inch high shoulders and shall be cast as a single unit of terrazzo. The sides of the service basin installed against any wall shall be provided with stainless steel tiling flanges cast integral with the basin and extending two (2) inches above the shoulders. On exposed side the service basin shall be provided with integral cast stainless steel caps extending over the top of the shoulder and extending at least 1 1/2 inches down the sides. Provide three (3) inch drain connection with stainless steel strainer plates and traps. Install counter-flashing as required.

2. Service sink fitting shall be equal to Chicago faucet No. 897 with bucket hook, wall brace, 3/4

inch threaded hose connection, vacuum breaker, and integral stops.

H. Roof Drains

1. Roof drains shall be Josam or equal.

2. Insulate drain body and all horizontal rain leaders.

22 47 00 Drinking Fountains and Water Coolers

.01 Drinking Water Cooling Systems

A. Electric Water Coolers

1. Electric water coolers shall be wall mounted, semi-recessed and shall be supported by carriers similar to Josam No. C-352.

2. The coolers shall be equipped with a basin of 18-8 stainless steel, bubbler, water valve and pressure regulator, a sealed refrigeration system with air-cooled condenser.

3. Front panel of unit shall be removable and unit shall be so constructed that the refrigeration unit can be removed without moving the cooler from the wall.

4. No "hot water for coffee" type dispensers are permitted.

5. In public areas the water cooler shall be accessible to the handicapped.

6. Coolers containing lead solder joints, storage tanks, or other elements constructed of lead that can be in contact with the drinking water are not acceptable.

22 60 00 GAS AND VACUUM SYSTEMS FOR LABORATORY AND HEALTHCARE FACILITIES

22 61 00 Compressed-Air Systems for Laboratory and Healthcare Facilities

.01 Compressed Air Systems

A. Air Compressors

1. When after coolers are specified on air compressors, they shall be air cooled or shall be cooled with re-circulating process water. Water cooling through equipment to drain is not permitted.

22 62 00 Vacuum Systems for Laboratory and Healthcare Facilities

.01 Vacuum Systems

A. Vacuum pumps shall be duplex type, similar to Nash Engineering Co.

22 67 00 Processed Water Systems for Laboratory and Healthcare Facilities

.01 High Purity Water Systems

A. The University prefers a central steam powered still for projects at University Park.

B. Any requirement for a higher grade water will be handled at the point of use, being fed from the central still unit.

C. On stills rated 5 gph and over, the steam powered heat exchanger shall be constructed of cupronickel, 10 percent nickel. The manufacturer shall verify in writing that the heat exchanger is so constructed.

1. We are picking up large amounts of copper deposits on the boiler tubes, so to eliminate this problem the University requests that no copper heat exchangers be installed.

D. Condensing water to drain is not permitted.

E. All parts of the still in contact with the steam vapor and distillate shall be tin or tin-coated copper. The tin must be 99.97 percent pure and the coating thickness a minimum of 0.001 inch. Specifications should be written around Barnstead.

DIVISION 23 – HEATING, VENTILATING, AND AIR-CONDITIONING (HVAC)

23 00 00 HEATING, VENTILATING, AND AIR-CONDITIONING (HVAC)

23 00 01 Owner General Requirements and Design Intent

.01 Summary of Design Intent

A. DESIGN FOR COMPLETENESS: All projects are expected to be complete at their conclusion, meaning that the project generates no need for additional efforts beyond the planned scope. Any expansion or renovation of conditioned space must include an assessment of the adequacy of the utilities infrastructure. Above all, the campus maintenance staff is not available to complete projects or provide remedies to problems caused by the project.

B. ENERGY CONSERVATION:

1. GENERAL: The University is extremely interested in initiatives in energy management such as sustainable building designs that effect lower operation costs and good stewardship of state funds and natural resources.

2. SPACE LAYOUT: The simplest and most effective method of energy conservation is to turn things off when not in use. To this end, spaces with similar occupancy schedules should be grouped together, to the extent possible, on the same HVAC system, to accommodate unoccupied shutdown.

C. SUSTAINABILITY: The following general design objectives shall be considered and utilized where feasible when designing or planning the construction of new buildings or renovation of existing buildings

1. Reduce environmental impact through respect for natural systems and the ecology of the site by considering building orientation, natural solar shading, incorporating renewable resource use and other innovative environmental impact reduction designs.

2. Ensure energy efficiency by incorporating the use of sustainable energy sources, reduce energy costs reduction strategies through integrated systems building design, maximizing the use of natural day light, daylighting, the use of energy efficient artificial lighting, passive heating/cooling and other cost effective energy conservation designs.

3. Ensuring resource conservation when considering the use of land, materials & building in the most efficient & effective manner through the use of pre-used construction materials, use of construction materials made from recycled materials, the minimizing construction waste, the use of water minimizing fixtures and other cost effective source conservation designs and activities.

4. Ensure the health & well-being of the building occupants & visitors through the use of low VOC materials (paint, cleaners etc.), efficient HVAC design with fresh air to maintain the recommended CO2 levels and other indoor air quality and indoor environmental enhancing designs and activities.

5. Strive to incorporate all the above sustainable approaches to achieve a comprehensive and holistic environmentally sustainable facility.

D. UTILITIES IMPACT POLICY: Each project is responsible for funding all utility infrastructure upgrades made necessary by that project.

E. UTILITY DESIGN:

1. Designer shall consult with current drawings, planning connections, and upgrades.

2. University is in the process of developing master plans. Contact Project Manager.

.02 Related Documents

A. The general requirements of the Penn State Office of Physical Plant Design and Construction Standards, including the Introduction, General Notes to the Professional and Contract Administration Division and General Conduct of the Work and Special Requirements apply to the work specified in this Division.

B. Utilities: (Refer to Division 33)

C. Systems Serving Classroom Areas: (Refer to Division 13).

.03 Definitions

A. BTU Conversion Factor: The following energy source to BTU conversion factors have been established for general University use:

1. Coal -------------------- 25 x 10^6 BTU/ton

2. #2 Fuel Oil ------------- 140 x 10^3 BTU/gal.

3. Electricity ------------- 3.412 x 10^3 BTU/k.w.h.

4. Steam ------------------- 1 x 10^3 BTU/lb.

5. Air Conditioning -------- 12 x 10^3 BTU/ton

6. Natural Gas ------------- 1030 BTU/ft.^{3}

B. These values are modified from time to time. The Professional shall consult the University for the most recent revisions.

.04 Submittals

A. Design Calculations: The University requires calculations to be submitted for all projects.

.05 Standard of Quality/Quality Assurance

A. General (Reserved)

B. Pressure Vessels

1. All pressure vessels shall be in accordance with the requirements of the Commonwealth of Pennsylvania, Department of Labor and Industry Code for Unfired Pressure Vessels.

2. Tanks and pressure vessels shall be inspected, stamped and certified to be constructed in accordance with the above code and the ASME Code for Unfired Pressure Vessels.

3. Operating certificates shall be turned over to the University upon completion of the project.

.06 Coordination and Space Planning

A. General: Refer to Space Planning requirements in the Introduction of the Design and Construction Standards.

B. Mechanical Rooms:

1. Mechanical rooms shall be designed in accordance with the most current version of all applicable codes.

2. Mechanical rooms shall be planned with sufficient size and equipment laid out to provide adequate maintenance clearances for all equipment; (i.e. for filter changes, tube and coil pull spaces, repair of components, etc.). Adequate means of access shall be provided for replacement of largest piece of equipment without removing general construction or moving other equipment. Minimize the need to do maintenance from ladders. Provide overhead structural steel with portable chain hoists to lift heavy motors, compressors, fans, etc. Provide adequate lighting.

3. Mechanical rooms shall be provided with an automatic ventilation system.

4. Mechanical rooms shall be provided with a minimum of one floor drain. Floor drains shall be piped to sanitary system.

5. Provide mechanical rooms with minimum one hose bibb with backflow preventer in supply piping.

6. All equipment drains, blow down lines, etc. shall be piped to a floor drain with an approved air gap fitting.

7. Mechanical rooms shall be located to provide access directly from the building exterior. Mechanical rooms shall not be located where vibration and/or noise would be objectionable.

C. Janitor Rooms

1. Janitor rooms are not accessible to maintenance employees. Therefore, mechanical equipment, valves, electric panels, thermostats, etc. are not to be placed in these rooms.

2. Refer to Division 23 00 10.03 for janitor room ventilation requirements.

D. Equipment Locations

1. Terminal units and air handling equipment shall not be located above an occupied space unless prior approval is received from the University. All equipment must be readily accessible for maintenance.

2. Floor mounted equipment shall be installed on concrete housekeeping pads. Pads shall be isolated from the surrounding slab if vibration requirements warrant.

3. All equipment installed on grade outdoors shall be installed on reinforced concrete pads. Foundation requirements shall be analyzed for large pad-mounted equipment.

4. Locations of mechanical equipment which affect the aesthetics of the building and Campus shall be approved by the Environmental Quality Board. Discuss approval procedures with the Project Manager.

5. Equipment above the finished floor level or roof level shall be provided with access platforms or walkways suitable for maintenance activities.

6. Equipment accessible to the general public shall be provided with screens, fences, or enclosures to deter vandalism and to prevent access to dangerous conditions.

23 00 10 Systems Selection and Application

.01 General

A. Construction documents shall clearly record all pertinent information and criteria related to the design, construction and intended operation of the HVAC systems. Such information shall include, but not necessarily be limited to:

1. Critical space temperature and pressure relationships to be maintained.

2. Construction phasing planning as required to minimize disruption to existing facilities and occupancies.

3. Future provisions including:

    a. Intentional oversizing of equipment or distribution systems and intended future connection points.

    b. Floor Space to be kept clear for future additional equipment.

    c. Provisions for major equipment replacement such as removable louvers or knock-out panels, etc.

4. Special operating instructions of systems, special purpose valves, dampers or manual/emergency type controls.

5. Shut-down and emergency instructions.

6. Intended summer and winter operating and change over instructions.

7. Any other special operating or maintenance instructions.

B. Equipment (Non-typical)or Process Load Criteria: Design criteria for specialized, non-typical equipment or process heat gains (excluding people, lights, conduction, and solar loads), in critical and special areas such as computer rooms, microcomputer labs, research labs, etc. shall be *scheduled on the drawings* by room number for future reference.

.02 Design Conditions

A. The following are general design guidelines for inside and outdoor design conditions.

Area Description	Season	Indoor	Outdoor	Comments
Comfort Areas	Summer	75°F DB/50%	90°F DB 74°F WB	1, 4 5
	Winter	72°F DB/25%	0°F DB	
Labs & Critical Areas	Summer	Consult w/User	92°F DB 74°F WB	Note 5
	Winter	Consult w/User	0°F DB	
Animal Rooms	Summer	Note 3	95° DB 75° WB	2 , 5
	Winter	Note 3	-10°F DB	2
Cooling Tower Selection	Summer		77°F WB	
	Winter			

NOTES

1. Consideration shall be given to morning warm-up cycle.

2. Typically these systems are required to be 100% outdoor air systems, therefore, the outdoor design conditions are altered for these and any other 100% outside air systems. Specified discharge air temperatures shall be maintained at all times.

3. As specified in the latest edition of "Guide for Care & Use of Laboratory Animals".

4. Operating control setpoints shall be as follows:

   a. Comfort Areas such as general office/classrooms

      1) Occupied: 70 heating, 75 cooling
      2) Unoccupied: 60 heating, 85 cooling
      3) Holiday Setback: 50 heating, 85 cooling

5. The University Park Campus chilled water system distributes chilled water at a supply temperature of 43°. Therefore, all chilled water coils must be selected to function at a supply chilled water temperature of 43° with a minimum ΔT of 12°. The exception to this requirement is chilled water coils that are expected to provide cooling year-round to isolated zones that are not practical to serve via airside economizer (examples: telecom/data closets, elevator equipment rooms). These chilled water coils must be selected to function at a supply chilled water temperature of 48°, which is the winter "free cooling" maximum supply water temperature.

.03 <u>General Pressure Relationship and Ventilation Requirements for Certain Areas</u>

Area Description	Pressure Relationship to Adjacent Areas	Minimum Outdoor Air Requirements	All Air Exhausted to Outdoors	Recirculation Permitted
Animal Rooms	Note 5	Note 5	Note 5	Note 5
Auditoriums	E	Note 1	No	Yes
Classrooms	E	Note 1	No	Yes
Computer Rooms	P	Note 1	No	Yes
Copy Centers	N	Note 1	Yes	No
Darkrooms	N	Note 1	Yes	No
Dining Areas	P	Note 1	No	Yes
Janitors Closets	N	Note 3	Yes	No
Kitchens	N	Note 1	Yes	No
Laboratories	Note 4	Note 1	Note 4	Note 4
Laundry	N	Note 1	Yes	No
Libraries	E	Note 1	No	Yes
Locker Areas	N	Note 1	Yes	No
Lounges	N	Note 1	No	Yes
Mech/Elect Rooms	N	Note 2	Yes	No
Music Rooms	E	Note 1	No	Yes
Offices	E	Note 1	No	Yes
PC Labs	P	Note 1	No	Yes
Toilet Rooms	N	Note 3	Yes	No

P = Positive, E = Equal, N = Negative

NOTES

1. Conform to ASHRAE STANDARD 62 Ventilation For Acceptable Air Quality (Latest Edition).

2. Quantity required to maintain maximum of 10° above Summer Outdoor Design DB temperature.

3. Transfer from corridors permitted. Exhaust air quantity shall be greater of 2.5 cfm/ft2 or 10 AC/HR or as required by ASHRAE STANDARD 62 Ventilation For Acceptable Air Quality (Latest Edition).

4. Discuss specific requirements with the University representative. Requirements may vary.

.04 Standby Equipment for Critical Areas

A. Standby equipment requirements shall be discussed with the Project Manager for systems serving critical areas such as:

1. Labs
2. Research Buildings
3. Animal Rooms
4. Main Frame Computer Rooms

B. Contract documents shall indicate equipment which is intended for standby service.

C. Animal Rooms, in addition to being tied into the main building chilled water system, shall have a totally independent air-cooled, chilled-water system to serve as backup during summer operation and to provide a year round supply of chilled water.

D. Auto changeover shall be provided for all standby equipment. Changeover shall be alarmed to CCS. Refer to Division 23 09 00.

.05 Emergency Shutdown

A. All systems shall be arranged for emergency shutdown requirements outlined in the applicable codes.

B. Emergency shutdowns shall be alarmed to CCS.

.06 Central Heating and Cooling Plant

A. CAMPUS CHILLED WATER:

1. Much of University Park Campus is, or will be, served by a campus loop chilled water system. The

chilled water system of each new building must be designed so as to be compatible with the characteristics of the campus chilled water system. New buildings shall have chilled water pumps (in a booster arrangement from the campus distribution loop with check valves and automatic control valves). Refer to Campus Chilled Water System Building Service Entrance Details (with our without heat exchangers as applicable).

2. Buildings served by a central chiller plant shall NOT have an automatic water make-up connection. Make provision for flushing and initial filling of the chilled water system using domestic water.

3. Expansion tanks shall not be installed in any part that directly connected to the campus chilled water system. Buildings provided with a heat exchanger will require an expansion tank (bladder type) in the building side of the heat exchanger, but NOT in the campus side.

4. Refer to Chilled Water System Sequence of Operation posted for the general requirements relating to Building Chilled Water Control Systems. Review and coordinate project specific modification requirements with University Chilled Water Utility Engineer

5. All buildings shall be provided with shut-off valves at the building entrance (inside the building) with manual air vents and drains on the plant side of the shut-off valves. Refer to Building Wall Penetration Detail.

6. All isolation valves shall be high performance butterfly valve, lug style.

7. Provide thermometers in thermal wells. Provide manifold pressure taps to a single gauge. Automatic air vents shall have isolation valves for replacement/maintenance. Manual air vents to consist of ¾” ball valves and necessary pipe/fittings to clear valve handle of insulation. Discharge from manual air vent valve to turn out horizontally from carrier pipe and be provided with hose bibb connection and cap on chain. Low point system drains are to be installed in similar fashion with ball valve, piping, hose bibb connection and cap. Provide air/water separators with a combination of manual and automatic air vents at all high points in system and drains at low points.

8. Emergency chilled water tie-in points shall be provided on air conditioning critical buildings such as animal facilities, computing centers, medical facilities, etc. Discuss with Project Manager for application.

.07 Zoning

A. Zoning of the systems shall be done in accordance with sound engineering judgment relating to varying load conditions, function of space, occupancy schedules, etc. Final zoning shall be discussed at conceptual design stage with the Project Manager. Rooms shall be individually controlled.

B. All Classrooms are to be separately zoned to allow cooling all year long, including those times when building air conditioning is turned off for the season. Refer to Division 13 for further references to General Purpose Classroom document that includes information on HVAC needs related to Classrooms.

.08 Water Systems

A. Glycol Dry Coolers

1. Utilize free cooling option for computer room systems when it is cost effective.

2. Refer to Detail [23 xx xx .xx]. *Details are not yet available in WEB-based manual.*

B. Process Cooling Water Systems

1. City water is not permitted to be used in "once through cooling" applications.

2. Laboratory equipment and other applications requiring specialized process cooling water shall be appropriately designed by the Professional. Specialized process cooling equipment or heat exchangers and pumps connected to other building condenser water loops may be utilized, if applicable.

3. The Professional's approach should be reviewed with the University early in the design process.

.09 All-Air Systems (General)

A. Ducted supply and return systems are required. Return plenums are not permitted unless prior approval is received.

B. One hundred percent shutoff VAV systems are not permitted. Minimum airflow must be maintained to satisfy ventilation requirements. Reheat shall be provided for all interior and exterior zone VAV boxes.

C. Economizer cycle (temperature controlled) shall be utilized on all systems for areas requiring year-round cooling.

D. For all systems five tons and over utilizing economizer cycles a separate return or exhaust fan must be utilized to provide positive relief and also standby capacity in the event of supply fan failure.

E. All sheet metal shall be specified to be constructed in accordance with the latest edition of SMACNA's HVAC duct construction standards.

F. It is the intent that duct leakage tests will not be necessary since the Professional will be specifying a high quality duct joint and seam sealant or sealing system to be installed on all ductwork constructed to static pressure classifications of 1" and greater.

1. The Engineer shall specify a duct static pressure construction classification, a duct seal classification and a duct leakage classification (when required) for all duct systems. All values shall be as recommended by SMACNA in "HVAC Air Duct Leakage Test Manual", First Edition-1985.

2. Duct Leakage Tests shall only be required for air systems with a 4" or greater duct static pressure construction classification.

3. Duct systems constructed to static pressure classes lower than 4" shall be inspected for leaks by a representative of the Professional’s office or the University prior to insulation of the duct system. All sources of audible noise shall be identified and sealed in accordance with the project specifications.

.10 <u>Computer Room Air-Conditioning Systems</u>

A. Main frame computer room air conditioning systems shall be package computer room units, glycol cooled, with free cooling option. In raised floor rooms, distribution shall be under the floor. Raised floor shall be high enough to provide adequate air circulation but in no case less than 12".

B. Units shall be equipped with trouble indicators, audible alarms with silencers and auxiliary contacts for shutdown upon detection of fire. All alarms shall be interconnected with CCS and the Contractor shall be required to demonstrate to a University Representative that each alarm is fully functional and connected to CCS.

C. Humidification shall be provided to satisfy computer requirements using building steam. Electronic steam generators shall not be used except where building steam is not available. Discuss exceptions with Project Manager.

D. Standby equipment shall be discussed with the Project Manager.

E. Refer to Detail [23 xx xx .xx] for piping. Details are not yet available in WEB-based manual.

.11 Micro and Personal Computer Lab Air Conditioning

A. See Paragraph 23 00 10.10.A, except that raised floors are not normally installed and distribution may be ducted overhead.

B. Humidification is not normally required.

C. Standby equipment is not required.

23 01 00 Operation and Maintenance of HVAC Systems

.01 General

A. Operation and Maintenance Information for Preventive Maintenance and Training:

The Office of Physical Plant implements a computerized preventive maintenance (PM) program of every new system or improvement. In order to have the PM program in place when OPP assumes responsibility for maintenance, the project information pertinent to the preventive maintenance must be provided considerably prior to project completion. Forty-five days before project completion is the minimum unless specified differently by the Project Manager. This information will be in the form of a bound document or three ring binder with copies of the pages from the manufacturers O & M manuals detailing the preventive and predictive maintenance routines and schedules for each piece of equipment or other entity requiring preventive maintenance. This document will also include a list of the room numbers of the restrooms and classrooms.

Operation and Maintenance information must be provided to Facilities Services prior to training.

This information may also be required when beneficial occupancy has been granted in the course of phased construction.

.02 Maintenance Manuals

A. Three (3) complete copies of the maintenance manual labeled as described herein shall be submitted to the University for approval in as many three (3) ring loose leaf binders as required. The copies shall be submitted a minimum of two weeks prior to any instructions and demonstrations to University personnel.

B. The manuals shall be typewritten and include a table of contents. The information shall be arranged in a logical order for use by the University in maintaining the projects.

C. The manuals shall include but not be limited to the following:

1. Table of Contents.

2. Materials list with place of purchase.

3. List of normally replaced items, such as filters, fuses, belts, seals, screens, etc., indicating style, rating, size, etc., and place of purchase.

4. Installation, servicing, maintenance and operating instructions for all systems and components with place of original purchase, and name, address and phone number of person servicing system.

5. Manufacturers guarantees and warranties.

6. Approved copies of shop drawing, including component wiring diagrams and ATC wiring piping diagrams of all installed systems indicating all connections, color coding, functions, locations, etc. Approved as noted shop drawings submittals shall be corrected to incorporate all approval notes prior to inclusion in Maintenance Manuals.

7. Schedule of all motors, starters and controllers under this contract with the following information included:

a. Location
b. All Nameplate data
c. Overload rating, and manufacturer's number
d. Actual full load amperes
e. Over-current protection

8. System and equipment start-up, seasonal changeover, and seasonal shut-down with pre-start checklists and precautions.

9. System and equipment troubleshooting guides.

10. Reference documents which shall include construction drawings list, record set of drawings list, test and balance records.

11. Testing and balancing procedures for each system(s) and system(s) components.

12. Copies of all inspection certificates and approvals from all inspection agencies.

13. Copy of an approved testing and balancing report.

14. Copy of all Mechanical Vibration Analysis and Alignment Verification Reports.

.03 <u>Tour/Instruction/Demonstration</u>

A. Maintenance Manuals

1. Maintenance manuals shall be furnished a minimum of two weeks prior to any instructions and demonstrations to University personnel. See Paragraph 23 01 00.02 for manual content.

B. Tours for University Personnel

1. At the completion of the work, immediately after Substantial Completion, the Contractor shall conduct a walk-through tour of the project work areas. The purpose of the tour shall be to introduce the University personnel who will have charge of the equipment or use of the space to the new areas. Generalities of the type of equipment installed shall be discussed during the tour.

C. Instructions to University Personnel

1. At the completion of the work, after the University has taken over use of the Building or work area, the Contractor shall instruct those University employees who will have charge of the equipment, the care, adjustment, and operation of all parts of the system. Such instruction shall cover a minimum period as specified, eight (8) hours per day, and shall be arranged for at the University's convenience.

D. Demonstration to University Personnel

1. In addition to the instruction period mentioned above, the Contractor shall demonstrate the automatic temperature control cycle, on a point-by-point basis, at every piece of controlled equipment to a specially designated University representative. Following this, the Contractor shall instruct maintenance personnel on all automatic temperature control equipment in the presence of this representative.

E. Maintenance and Operations personnel shall be given a minimum two-week notice of each of the above scheduled tour or instruction dates.

.04 Start-Up

A. The Contractor shall arrange for special start-up service from the equipment manufacturer, or his appointed agent, for the following equipment:

1. Chillers
2. Boilers
3. Pumps
4. Air Handling Units
5. Cooling Towers
6. ATC Systems

B. The start-up shall include, but not necessarily be limited to:

1. Alignment and Balance
2. Lubrication
3. Electrical Connections, Voltage, Rotation
4. Motor Amperage Readings
5. Pump Discharge and Suction Readings
6. Chiller Head and Suction Pressures
7. Condenser Water Flow and Temperature
8. Chilled Water Flow and Temperature Chiller Lock, Sequences and Safety Controls
9. Water Systems

10. Supervise Flushing and Cleaning

11. Take pH Readings

12. Water Treatment-heating systems, cooling systems, and condenser water systems

13. Combustion Analysis

14. BAS tuning and calibration

C. Maintenance and Operations personnel shall be given minimum two-week notification of scheduled start-up date to observe procedures. This does not preclude the requirements for operating instructions.

D. Following start-up, the manufacturer shall submit a report on his findings to the Contractor with a copy to the University. If the project is State funded, include a copy of the report for the Department of General Services.

.05 Warranties

A. The specifications shall be prepared to include a one-year guarantee for the entire installation. The following components or systems shall be specified with an extended warranty period:

1. Compressors - Five (5) years

2. BAS Systems - Two (2) years

B. The warranties shall cover parts and labor for the duration of the warranty period.

C. Routine preventive maintenance shall not be included as part of the warranty service.

23 05 00 Common Work Results for HVAC

23 05 01 Mechanical General Requirements

.01 Motors and Drives

A. Motors

1. All motors over 1/2 hp shall be ball bearing unless otherwise noted.

2. All ball bearing motors shall be equipped with lubricating type bearings, and provided with one (1) grease fitting per bearing and one (1) removable plug per bearing in the bottom of the grease sump to provide for flushing and pressure relief when lubricating. Motors shall be permanently marked that bearings are lubricating type bearings. Where motor grease fittings are not accessible, extend 1/8" steel or copper tubing from fitting to an accessible location.

3. Motors 3/4 hp and larger to be three phase, 60 hertz.

4. Motors smaller than 3/4 hp to be single phase, 60 hertz, 120V and shall have built in thermal protection.

5. All motors above 1 hp shall be the low loss - high efficiency type. Motors shall be tested in accordance with NEMA standard MG1 1.536 and name plate shall indicate the index letter.

6. All 3-phase motors larger than 5 hp shall have power factor correction capacitors as recommended by the manufacturer.

7. Motor inrush current must not create a voltage sag in excess of 3 percent without specific University approval.

8. A voltage sag report shall be completed by the Professional on selected projects as determined by the University. Report shall include backup calculations and expected building voltage sag when motor or motors in question are started.

9. The University has experienced widespread premature motor shaft bearing failures due to fluting from electrical arcing on motors equipped with Variable Frequency Drives. The Design Engineer must specify appropriate technologies and/or include provisions in the system design to prevent electrical fluting induced premature bearing failure from occurring.

B. Drives

1. All belt driven equipment shall include properly selected adjustable sheaves and matched V belts, all rated for 150% of motor horsepower. Proper expanded metal guards should be provided for safety protection and to allow for proper ventilation for cool operation of belts. Solid sheaves and band belts shall be used to minimize vibration in multiple V-belt driven equipment.

2. Motor grease fittings shall be extended so belt guards do not need to be removed.

3. All adjustable sheaves shall be replaced with suitable fixed sheaves prior to final acceptance by the University.

.02 Pressure Gauges and Thermometers

A. Gauges for general use shall be "Quality" type as manufactured by Marsh Instrument Company or equal. Gauges shall have a 4 1/2 inch diameter dial. In main mechanical room, HVAC Contractor shall provide 6" diameter gauges for all steam pressures and pumped condensate pressure. The Plumbing Contractor shall provide similar gauges for water and air. Gauges shall be calibrated for static head. All gauges shall be equipped with shutoff valves and snubbers.

B. Siphons shall be used with all steam gauges. Also, all gauges shall have gauge cocks or valves suitable for the pressure involved.

C. Thermometers for general use shall be stem type with an adjustable bracket. Thermometers shall be organic liquid filled (red) in lieu of mercury filled.

D. The scale on gauges and thermometers shall be read to twice the operating pressure or temperature. The Professional shall specify gauge and thermometer ranges.

.03 Valves

A. General

1. All valves on any one project shall be the product of one manufacturer.

2. Valves shall be right handed. Balancing valves shall be a type that can be used for shut-off without disturbing balancing point setting.

3. Where possible, valves shall be installed with valve bonnet in an upright position to prevent deterioration or corrosion of bonnet and packing.

4. Valve body materials shall be compatible with piping system materials.

B. Pump Valves

1. All constant speed circulating pumps shall have a triple duty valve installed on the discharge side of the pump.

2. Triple duty valves shall not be used on pumps equipped with variable speed drives.

C. Shutoff Valves

1. Isolation shutoff valves shall be installed at each piece of equipment, terminal unit, and each branch takeoff to facilitate shutdown for repair. Positive shutoff balancing valves with memory may satisfy this requirement at terminal units.

D. Balancing Valves

1. Balancing valves shall be installed in all 3-way control valve bypass lines and at all flow meters.

2. Gate valves shall be limited to shutoff service only. Gate valves shall <u>not</u> be used in a throttling application. Globe valves or ball valves shall be used.

E. Check Valves

1. Where check valves are required, check valves shall be installed on the equipment side of all shutoff valves to facilitate servicing the check valve.

F. Drain Valves

1. Drain valves shall be a minimum of 3/4" with hose end connection.

.04 <u>Pipe Hangers and Supports</u>

A. Provide an adequate pipe suspension system in accordance with the current version of the International Mechanical Code, recognized engineering practices, using standard, commercially accepted pipe hangers and accessories. The use of pipe hooks, chains, or perforated iron for pipe supports will not be accepted.

B. Contractor shall submit Data sheets for approval on all pipe hanger items prior to installation.

C. All piping shall be arranged to maintain the required pitch and provided for proper expansion and contraction.

D. No holes are to be drilled or burned in structural building steel for hanger rod supports.

E. Vertical runs of pipe shall be supported with riser clamps made specifically for pipe or for tubing.

F. Where concentrated loads of valves and fittings occur, closer spacing may be necessary. Hangers must be installed not more than 12 inches from each change in direction of pipes.

G. All hangers for piping shall be provided with a means of vertical adjustment. If adjustment is not incorporated in the hangers, use turnbuckles.

H. Provide piping suspension systems with vibration isolation capability as required. For vibration isolation requirements of piping suspension systems, refer to Sound and Vibration Control, 23 05 01.05.

I. Copper clamps and hangers shall be used on copper piping.

.05 Sound and Vibration Control

A. Vibration Control Requirements

1. Mechanical and electrical equipment and associated piping and duct work shall be mounted on vibration isolators as specified and shown in equipment schedules and as required to minimize transmission of noise and vibration to the building structure or spaces within.

2. All rotating equipment shall be balanced both statically and dynamically. The equipment supporting structure shall not have any natural frequency within plus or minus 20% of the operating speed. The equipment, while operating, shall not exceed a self-excited RMS radial velocity of greater than 0.10 inches/second. Vibration pick-ups shall be placed on the bearing caps in the horizontal, vertical, and axial directions, or on the equipment supporting structure if the bearing caps are concealed.

a. Accelerometers shall be permanently placed on all pieces of equipment in hard to reach or unsafe areas. The University has standardized on 100 milli-volts/(g) with an accuracy of plus and minus 5 to 10 percent and BNC connections. The University is currently using Wilcox or SKF accelerometers and an SKF Microlog CMVA60 detection monitor.

b. Critical areas should be discussed with the University. Tighter tolerances may be desired in certain circumstances.

3. The specifications shall require the Contractor to hire a third party vibration analyst to conduct baseline vibration signature tests of specified pieces or classes of equipment. The Professional shall review the proposed equipment for the project with the University and agree upon which type of equipment to include in the specifications for vibration analysis. This process should be accomplished as early during the design phase as possible. The specifications shall also state that the University's Commissioning Contractor shall witness and/or verify the accuracy of the Vibration Contractor's test results. If an abnormal amount of equipment fails the Commissioning Contractor's verification (% to be determined on a project basis), the vibration tests by the Contractor must be repeated for all equipment.

4. Where equipment vibration exceeds manufacturer’s recommendations or levels specified, the Contractor shall make corrections to reduce vibration frequencies and amplitude to within specified limits. If this cannot be accomplished, the equipment shall be replaced with equipment that will meet all requirements of the specifications.

5. The Contractor shall be required to submit a report for approval by the University and the Professional. The report shall include vibration analysis and alignment data of all specified rotating equipment. The report shall be submitted in paper and electronic format. The electronic data shall be submitted in a form that may be imported to SKF's Prism 4 Solutions software program.

B. Equipment Isolation

1. Isolation shall be stable during starting and stopping of equipment. Lateral thrust restraint isolators shall be provided where necessary to prevent excessive lateral movement under equipment start-up and stop conditions. Lateral thrust isolators shall not interfere with vertical isolation.

2. Isolation shall be selected for the operating speed of the equipment. Where the equipment is controlled by a variable frequency drive, the isolator shall be sized for the lowest expected operating speed.

3. Isolators located outdoors shall be hot-dipped galvanized.

4. Isolators shall be selected and located to produce uniform loading and deflection even when the equipment weight is not evenly distributed.

5. Base type, isolator type, and required minimum (not nominal) deflection shall be part of all equipment schedules shown on drawings and/or in specifications.

6. Unless otherwise specified, said base types, isolator types, and deflections shall be taken from the "Selection Guide for Vibration Isolation" table in the Sound and Vibration Control chapter of the ASHRAE Applications Handbook, current edition.

    a. Fan and motor assemblies in air handling units may be internally spring isolated. In which case, external isolation shall not be provided.

    b. Packages containing other rotating equipment, such as compressors and pumps, shall be externally isolated.

C. Piping and Ductwork

1. Vibration isolation shall be provided for piping and ductwork as follows:

    a. All high pressure ducts (over 6" wg) for 50' from vibration isolated air handling equipment.

    b. All piping located in mechanical rooms, or for a distance of 50', whichever is greater. Pipe hanger isolators shall have the same deflection as that supplied for equipment to which the piping is attached.

    c. The vibration isolator units selected shall not deter the thermal movement of the piping or the expansion compensator from performing its required task.

D. Flexible Connections

1. Flexible duct connections shall be provided adjacent to air handling equipment.

2. Flexible piping connections shall be provided at piping connections to all rotating mechanical equipment mounted on vibration isolators.

3. Flexible conduit, equal to 150% of the distance between motor connection and adjacent attachment point, shall be provided for electrical connections to all vibration isolated equipment.

E. Interior Sound Pressure Level Requirements

1. The maximum interior sound pressure levels, due to installed HVAC equipment, shall not exceed those shown in the table of design guidelines for HVAC-related background sound in rooms in the chapter of Sound and Vibration Control, ASHRAE Application Handbook, current edition, unless otherwise specified.

   a. While these guidelines are labeled as RC values, they shall be interpreted as NCB guidelines (per ANSI Standard S12.2).

   b. The RC Mark II method shall be used for investigating room noise problems in the field, per the above noted ASHRAE Handbook chapter.

F. Exterior Sound Pressure Level Requirements

1. Equipment installed outside the building, at grade, in areaways, attached to walls, and on the roof, such as cooling tower fans, air conditioning units, refrigerant condensers, fans, exhaust silencers, air intakes, etc. shall comply with all local, city, state, and federal requirements.

.06 <u>Mechanical Identification</u>

A. By Professional

1. All Mechanical drawing symbols used shall be in accordance with standards of accepted practice. The University's Equipment Identifier Prefix Acronym Standard (available on the OPP Design & Construction Standards Home Page) shall be used when naming all equipment for a project.

2. All equipment shall be individually numbered on the drawings by the Professional (for example--unit heaters, use UH-1, UH-2, etc., even though

both units may be the same size and type). Numbers shall be in accordance with the University's Central Control System (CCS) numbering guidelines. On renovation projects, numbers shall be in sequence with the CCS numbering scheme already in place for the building. The Professional should consult with CCS to obtain these numbers.

B. By Contractor

1. Equipment

a. All equipment, including associated electrical devices, shall be tagged in accordance with the University's CCS numbering guidelines. Tags shall be engraved, black, laminated, micarta tags with white reading symbols secured to equipment (not motor), usually inside access door for equipment in finished areas and exposed in all other areas. Tags should be mechanically fastened to equipment. DO NOT USE GLUE OR WIRE.

2. Piping and Ductwork

a. Three-fourth-inch wide, adhesive-backed vinyl cloth labels shall be used on all piping 2" and smaller. Label lettering shall identify both the medium being conveyed and the direction of flow.

b. Two-inch-wide, adhesive-backed vinyl cloth labels shall be used on piping greater than 2" and on all ductwork. Label lettering shall identify both the medium being conveyed and the direction of flow.

c. Labels shall be spaced maximum 15' centers. Position labels for easy viewing.

d. Identification of piping and ductwork may also be stenciled in a neat manner following the size and spacing guidelines as previously listed.

3. Valves

a. Valve tags - 1" x 2" laminated, black micarta attached by 10 gauge brass "S" hook. Valve numbers to be engraved as large as possible and to read white.

b. Valve charts shall be typewritten on white bond paper and mounted in a glass-front frame. Charts shall indicate service, number and location.

c. On renovation projects, contractor shall be directed to revise existing valve charts as required.

C. University Mechanical Color Code

1. In addition to the usual painting called for under the mechanical trades, the University uses a piping color code. The following color designations conform to the system established by the American Standards Association.

2. In general, the following color coding rules will apply:

   a. Red - Rust-Oleum #1210 or equal

      1) Fire protection
      2) Stop

   b. Blue - Rust-Oleum #721 or equal

      1) Warning against moving, equipment, etc., operating, or use of equipment, etc., without authorization.

   c. Yellow - Rust-Oleum #722 or equal primer

      1) Caution
      2) Other uses as designated by code

   d. Gray – MAB Ply-Tile #504A-11 undercoat

      1) All masonry walk and interior plant structures other than equipment, boilers, etc., to be light gray color similar to Rust-Oleum #906 silver gray, with traffic areas 4 feet from floor a dark gray similar to Rust-Oleum #975 gray.

   e. Orange – Rust-Oleum #1151 or equal

      1) Dangerous materials
      2) Other uses as designated by code

   f. Green – Rust-Oleum #594 or equal

      1) Safety
      2) Safe materials

3. Specific Colors for Piping will be as follows:

   a. Air Piping (Compressed) – Yellow with Green (Pressure under 100 psig)

b. Air Tanks (Compressed) – Yellow with Green Band

c. Anchors – See Hangers

d. Ash Vacuum System – Dark Gray (Rust-Oleum #975 or equivalent)

e. Blow down Lines – See Drains

f. Boilers – Light Gray except hot surfaces to be heat-resistant aluminum

g. Carbon Dioxide – Yellow with Black Band

h. Chemical and Brine Tanks – Green with Labels

i. Chilled Water – Green with White band

j. Chlorine Water Solution – Yellow with White Bands

k. Combustible Gases – See type of Gas

l. Condensate – Green with Red Band

m. Conduit – To be painted to match surface to which attached, i.e., wall or ceiling. When suspended, such as the run out to a motor, treat as equipment and paint Gray.

n. Cooling Tower Water – Green with Yellow and White Band

o. De-mineralized Water – Green with Gray Band

p. Decorator Tanks – Aluminum (heat resistant)

q. Domestic Water – See Potable Water

r. Drain Lines – Aluminum with Red Bands

s. Effluent Water – Green with Yellow Band

t. Feed Water – High Pressure – Orange with Green Band

u. Feed Water – Low Pressure – Green with Orange Band

v. Fire Lines – Red

w. Gas – See type of Gas

x. Hangers – Portion actually supporting; i.e., surrounding pipe, is to match pipe. Remaining portion to be Black.

y. Hazard Striping – Where applicable

z. Heating Water – See Water

aa. Hot Water Storage Tank – Green with Labels

bb. Hydrants Fire – Red

cc. Hydraulic Oil – Yellow with Red Band

dd. Natural Gas – Orange with White Band

ee. Nitrous Oxide – Yellow with Black Band

ff. Oil – Yellow with Red Band

gg. Oxygen – Yellow with Black Band

hh. Propane – Orange with White Band

ii. Potable Water – Green

jj. Refrigerants – Yellow with Black Bands

kk. Return – See type of return, such as hot water condensate, etc.

ll. Sanitary Sewers – Aluminum with Red Bands

mm. Sewage Gas – Orange with Black Band

nn. Sludge (Sewage) – Dark Brown with White Band

oo. Soft Water – See Water – De-mineralized

pp. Softener – Green with Labels

qq. Steam piping – High Pressure (over 50 psig) – Orange

rr. Steam Piping - Low Pressure (below 50 psig) – Yellow

ss. Utility Water (Non-Potable) – Green with Yellow Band

tt. Water Tanks – Green with Labels

4. Miscellaneous:

a. Do not Paint valve wheels, lever operators, or controls.

b. Scaffolding, ladders, barriers, etc., should be Blue.

c. Use hazard striping where necessary, such as at the head of stairs and where head room is minimal.

d. All stair treads, risers, etc., are to be #9182 Rust-Oleum or equivalent. All painted railings are to be Light Gray with liberal applications of hazard stripping.

5. In general, the basic color schemes will be as follows:

a. Equipment--Light Gray or Aluminum
b. Walls--Light and Dark Gray
c. Floors--Light Gray or Tile Red

6. Other Requirements

a. In unfinished areas, including attics, crawl spaces, tunnels, and above suspended ceilings, the contents of the pipe and direction of flow should be indicated by 8-inch color bands painted or applied around the pipe at 20-foot intervals.

b. Piping in finished areas should be painted out in the scheduled room colors and should then be color-coded with 4-inch color bands painted or applied to the piping or piping covering where the piping enters and leaves the finished areas.

c. The painting of exposed heating and ventilating work, plumbing work, and electrical work in finished rooms should be specified to be included under General Construction Painting Section. The painting of color code identification, stenciling of contents, directional arrows, etc., should be the responsibility of the respective Contractors.

.08 Access Panels

A. Access panels are required in each situation where items requiring maintenance are located above a concealed ceiling.

B. Use screwdriver actuated locks.

C. Access panel sizes shall be suitable for application.

D. Access panel locations shall be indicated on contract drawings.

E. Access panels are not required in lay-in ceilings, but identify appropriate tile with color button, cleated through, located on the adjacent ceiling grid. Use color code of principal service.

23 05 93 Testing, Adjusting, and Balancing for HVAC

.01 Testing and Balancing

A. All testing and balancing shall be done in accordance with the National Environmental Balancing Bureau (NEBB) or Associated Air Balance Council (AABC).

B. On major construction projects, as determined by the University, the balancing subcontractor must be certified by AABC or NEBB.

C. Procedures

1. The environmental systems including all equipment, apparatus and distribution systems shall be tested and balanced in accordance with the AABC or NEBB Procedural Standards.

2. Fume hood testing shall be in accord with the procedure outlined in the AABC manual.

3. All instruments used for measurements shall be accurate, and calibration histories for each instrument shall be available for examination. Calibration and maintenance of all instruments shall be in accordance with the requirements of AABC or NEBB.

4. Accuracy of measurements shall be in accordance with AABC or NEBB Standards.

5. During the operating tests of the chilled water system, provide, if necessary, a false load equal to full capacity on the chiller and submit data on gpm flow, pressure drop, inlet and outlet temperatures of chilled water, amperage of chiller and ambient air temperature at condenser.

6. In addition, the Contractor shall check the operation of all automatic temperature control equipment; verify all thermostat, aquastat, airstat, etc., set-points and operations; and enlist the aid of the control Subcontractor to make necessary adjustments where required.

D. Reports

1. Eight copies of the final reports shall be submitted on applicable AABC or NEBB Reporting Forms for review and approval by the Professional and University.

2. Each individual final Reporting Form submitted must bear the signature of the person who recorded the data and the signature of the testing and balancing supervisor of the performing firm.

3. If more than one certified firm performs the TAB work, all final reports shall be submitted by that certified firm having managerial responsibility.

4. Identification of all types of instruments used and their last dates of calibration will be submitted with the final report.

5. The final test report shall include appropriate reference to all problems regarding the system(s) encountered prior to, during and after testing and what action taken to correct the problem(s), including noise and vibration.

6. Each report shall include a print, (or sketch) reduced in size, showing all supply, return, and exhaust air outlets for easy reference to report data.

7. An approved copy of the balancing report shall be included in the Maintenance Manual submittal.

E. Fan Sheaves

1. It is unacceptable for a balancing contractor to indicate that a system has been balanced as far as the existing sheaves permit. Change pulleys, belts, sheaves, etc., as required.

2. All adjustable sheaves shall be replaced with suitable fixed sheaves prior to final acceptance by the University.

23 07 00 HVAC Insulation

.01 Insulation

A. Fire Hazard Ratings

1. All insulation shall have composite (insulation jacket and adhesive used to adhere the jacket to the insulation) Fire and Smoke Hazard ratings as tested under procedure ASTM E-84, NFPA 225 and UL 723 not exceeding:

   a. Flame Spread 25

   b. Smoke Developed 50

2. Accessories such as adhesives, mastics, cements, and cloth for fittings shall have the same component ratings as listed above.

3. Paper laminate jackets shall be permanently fire and smoke resistant. Chemicals used for treating paper in jacket laminates shall not be water soluble and shall be unaffected by water and humidity. The only exceptions to the above are flexible foamed plastic insulation.

B. General

1. All pipe insulation shall be continuous through walls, partitions, ceiling openings and sleeves where fire and smoke ratings permit such penetration.

2. Where pipes pass through fire-rated floors, walls, or partitions, the use of a UL approved system for through penetrations is required. The annular space around the pipes shall be packed with mineral wool or other noncombustible material and sealed at each exposed edge to maintain the rating of the system in accordance with the through penetration sealant manufacturer's recommendations.

3. Insulation on all cold surfaces must be applied with a continuous, unbroken vapor seal. Hangers, supports, anchors, etc., that are secured directly to cold surfaces must be adequately insulated and vapor sealed to prevent condensation.

4. Edges of vapor barrier insulation at valve stems, instrument wells, unions and other raw edges must be adequately sealed to prevent moisture from penetrating the insulation.

C. Insulation Protection Shields:

1. Insulation protection shields fabricated from galvanized steel shall be installed at all pipe hangers and supports. Shields shall span an arc of 180°.

2. Provide shield lengths and thicknesses as outlined in the latest version of the International Mechanical Code or MSS-SP69.

3. Rigid cellular glass insulation, capable of resisting the crushing effect of the hydraulically loaded piping, shall be placed under each shield. Jacketing material shall be wrapped around rigid insulation and adjacent top and butt sections to maintain the jacketing continuity.

4. An 18 gauge stainless steel shield shall be installed on insulated piping located on the roof. The shield shall be a minimum length of 36 inches and field located to prevent damage to the insulation while walking over the piping.

D. Duct Insulation

1. Insulation systems shall conform to requirements in ASHRAE Standard 90.1-1999.

2. The use of duct liner is discouraged. Duct liner may be considered for acoustical purposes only with the written approval of the University.

3. All duct insulation in mechanical rooms shall be rigid fiberglass board, minimum density 6 lb/ft^3. All other duct insulation shall be blanket-type insulation wrapped on the outside of the ductwork.

E. Pipe Insulation

1. Insulation systems shall conform to requirements in ASHRAE Standard 90.1-1999.

2. In general, refrigerant piping systems shall be insulated with elastomeric pipe insulation.

3. In general, all other piping systems shall be insulated with fiberglass piping insulation with an all-service jacket. Fittings, flanges, and valves shall be insulated with fiberglass inserts and premolded polyvinyl jackets.

4. Special insulation protection shall be considered for areas subject to abuse, moisture, etc. (i.e. outside, wash down areas).

F. Equipment Insulation

1. In general, equipment shall be insulated with elastomeric or mineral fiber insulation. All equipment handling a medium below ambient temperature shall be additionally provided with a sealed vapor barrier.

2. The following equipment must be insulated to the fullest extent possible. Removable "Hot Cap" insulation must be provided for those items that will require insulation removal for periodic maintenance or inspection. This includes many of the items listed below.

a. Steam

1) Valves, strainers, pressure reducing valves, pressure relief valves, traps, and condensate receivers/pumps, flash tanks, heat exchangers

b. Hot water

1) Valves, strainers, pumps, expansion tanks, air eliminators, storage tanks.

c. Chilled water

1) Pumps, valves, heat exchangers.

23 09 00 Instrumentation and Control for HVAC

.01 General

Refer to "Building Automation and Control Systems" web sites on the Penn State Design & Construction Standards Page <http://www.opp.psu.edu/construction/standards/design_standards.cfm>.

23 20 00 HVAC PIPING AND PUMPS

23 21 00 Hydronic Piping and Pumps

.01 Hydronic Systems (General)

A. Follow Bell and Gossett guidelines for air separation. Use an air separator, with an automatic air vent, on the suction side of the pump. Pump away from converter. Manual vents are standard but automatic vents will be considered in special situations and locations. Where vent location is high or otherwise inaccessible, install valve at vent chamber, then extend 3/8" tubing to nearest janitor sink or mechanical room floor drain and terminate with ball valve. Use automatic water feed set to maintain proper system pressure. Add cold water make-up at air vent line above air separator.

B. Ethylene Glycol systems shall be considered when outside air at a temperature below 20 degrees exceeds 50% of the total air stream. However, the professional shall not specify Ethylene Glycol systems until specifically approved by the University. See 23 25 00 for more information.

C. All hot and chilled water systems shall be chemically cleaned after all items of equipment have been connected to the system and all piping has been completed. Cleaning shall be done prior to installing chemical treatment or glycol, and prior to acceptance by the University. See 23 25 00 for more information:

1. Notify the University at least one week in advance of the date and time that system cleaning is to take place. The University shall observe the system cleaning process.

D. All air handling and terminal unit coils shall be provided with flow measuring devices.

E. Reduced pressure principal back flow preventers shall be installed on all make-up water lines.

23 21 13 Hydronic Piping

.01 <u>Piping</u>

A. Piping shall be pitched and valves installed to facilitate complete drainage of the system.

B. All piping run within the building shall be run concealed in the finished portions of building in pipe spaces, ceilings or furred chases and exposed only in mechanical rooms and where shown on the drawings.

C. No pipe shall pass in front of or interfere with any openings, door or window. Head room in front of openings and doors shall in no case be less than the top of the opening.

D. Piping shall not pass exposed through electrical rooms or be erected over any switchboard or other electrical gear.

E. Pipe sizes shall be indicated on the plans at each change in direction and at all branch take off locations.

F. Provide 2-inch clearance between insulated piping and other obstructions.

G. Unions:

1. No union shall be placed in a location which will be inaccessible.

2. Unions shall be installed adjacent to all equipment for repair and replacement.

H. Electrolysis Control:

1. Electrolysis control between dissimilar materials shall be achieved through the use of dielectric nipples and a non-dielectric union. Dielectric unions shall be avoided whenever possible.

I. Bypasses:

1. Three valve bypasses shall be installed around control valves and pressure-reducing stations serving critical areas. Areas deemed to be critical shall be reviewed with the Project Manager.

2. In all applications, use ball valves for shut-off purposes and globe valves for throttling purposes in the bypass line.

   a. Gate valves may be used for shut-off purposes in large line sizes.

   b. Ball valves equipped with “characterizing discs” may be used for throttling purposes in lieu of globe valves.

3. In water applications, ball valves may be used for throttling and shut-off service.

4. No other equipment is to be provided with a bypass unless approved by the Project Manager.

J. Sleeves:

1. All pipes passing through wall or floor construction shall be fitted with sleeves. Each sleeve shall extend through its respective floor, wall or partition and shall be cut flush with each surface unless otherwise specified. Sleeves shall be two pipe sizes larger than the pipe when un-insulated and of sufficient size to allow for the insulation without binding. Floor sleeves in mechanical rooms shall extend 4 inches above finished floor, all other spaces minimum one inch above finished floor.

2. Sleeves in bearing walls, masonry walls, masonry partitions, and floors shall be standard weight steel pipe finished with smooth edges. For other than masonry partitions, through suspended ceilings and for concealed vertical piping, sleeves shall be No. 22 USG galvanized steel.

3. Where pipes pass through waterproofed floor or walls, design of sleeves shall be such that waterproofing can be flashed into and around the sleeves.

4. Sleeves through exterior walls below grade shall have the space between pipes and sleeves caulked watertight.

5. Install one-piece chrome-plated escutcheon plates with set screw at sleeves for all pipes exposed in finished areas.

6. The annular space between sleeves and pipe shall be filled with fiberglass insulation and caulked in non-fire rated situations.

7. Where pipes pass through fire-rated floors, walls, or partitions, the use of a UL approved system for through penetrations is required. The annular space around the pipes shall be packed with mineral wool or other noncombustible material and sealed at each exposed edge to maintain the rating of the system in accordance with the through penetration sealant manufacturer's recommendations.

K. System and Equipment Drains:

1. All piping shall be arranged to completely drain the system. Drain locations shall be located at all system low points.

2. Where sectionalizing valves are installed, a drain shall be installed on downstream side of valve to drain that section of the system.

3. All cooling tower drains and overflow are to be piped to sanitary system (not onto roof).

4. All system and equipment drains are to be piped to a floor drain.

L. Welding:

1. All welding shall be done in accordance with the AWS.

2. All boiler, pressure vessel, and gas piping welding must be done by certified welders as required by applicable codes.

3. All welding must be done with portable welding machines.

M. Pressure Tests:

1. All piping must be tested prior to receiving insulation.

2. Test pressures shall be minimum 1 1/2 times system operating pressure or as specified by the Professional.

3. Pressure tests must be witnessed and acknowledged in writing by a University representative.

.02 <u>Hot Water, Chilled Water, Vent Piping</u>

A. All supply water piping shall be graded up and return graded down in the direction of flow. At all high points in the piping system, manual air vents shall be installed to eliminate air pockets at initial fill. Drains shall be installed at all system low points.

B. All water piping shall be black steel pipe, ASTM A-53, Grade B or copper, Type 'L', hard drawn. Schedule to meet pressure requirements

C. Pipe fittings two inches and smaller shall be screwed or soldered as applicable; 2-1/2 inches and larger shall be soldered, welded, flanged, or Victaulic, as applicable.

.03 <u>Hydronic Specialties</u>

A. Strainers

1. Strainers ahead of circulating pumps should be large mesh (at least 3/16") and stainless steel construction. All strainers shall be valved and capped for blowdown.

B. Air Separators

1. Air separators shall be installed in each hydronic system. They shall be full-line size.

2. Air separators two inches and larger shall have tangential inlets and outlets, ASME rated, strainer with blowdown.

C. Expansion Tanks

1. Tanks shall be diaphragm type, ASME constructed, complete with inlet and air charging valve.

D. Flow Balancing Valves

1. Flow balancing valves shall be installed at all terminal equipment and air handling units and all major branch connections.

2. For all line sizes, use differential pressure type similar to B & G Circuit Setter.

3. Size balancing valves for the specified flow rates, which may not necessarily be the same as the line size.

E. Side Stream Water Filters

1. Side stream water filters shall be used on all heating and/or cooling closed piping systems and on all open recirculating systems (cooling towers).

2. The Professional shall follow the University's water treatment guidelines found in The Design and Construction Standards 23 25 00 for a more complete description of the requirements for side stream water filters.

.04 <u>Cold Water Make-up Piping</u>

A. All cold water piping shall be Type 'L' hard drawn seamless copper tubing.

B. All cold water piping joints shall be soldered, no lead type.

C. Provide parallel filters on all incoming make-up water lines.

D. Provide a (RPZ) reduced pressure principle backflow preventer.

E. Cold water make-up piping is not to be directly connected to any system that utilizes glycol.

.05 <u>Gauge Piping</u>

A. All gauge piping on hydronic systems shall be extra-strong IPS red brass piping federal specification WW-P-351, Grade A, with threaded joints.

B. For high pressure steam systems, pressure gauge connections shall be suitable for the maximum allowable working pressure and temperature, but if the temperature exceeds 406°F, brass or copper pipe or tubing shall not be used. The minimum size syphon shall be 1/4" inside diameter. For low-pressure steam systems, all gauge piping shall be non-ferrous.

C. Provide gauge cocks (low pressure) or gate valves (high pressure) for isolation.

.06 Cooling Coil Condensate Drain Piping

A. Cooling coil condensate drain piping shall be Type L, hard drawn, seamless copper tubing. Schedule 40 PVC with solvent weld joints may be used when there is no risk of hot water draining into the system. PVC shall not be used in air plenums.

B. Provide a trap for twice system total static pressure or 2" minimum.

C. No piping less than 1" in diameter.

D. Provide cleanouts at traps and other locations as required.

.07 Blowdown Piping (Boiler)

A. Schedule 80, black steel, welded.

B. Pipe to funnel type floor drain or approved receptor.

C. For high pressure boilers (over 15 psig steam), specify a heat recovery unit on the blowdown system. Flash steam could be utilized at the deaerator or other low pressure applications and hot water could be used to pre-heat the boiler make-up water.

1. Verify with the University, or with the local municipal authority, the permissible maximum temperature of waste water.

.08 Ground-coupled heat pump well field systems

A. The University encourages the use and application of equipment that reduce the energy consumption of building systems. However, the installation of ground-coupled or geothermal wells have groundwater contamination risks that must be addressed prior to design of any geothermal or ground-coupled systems.

B. Prior to the start of design, the Design Professional shall review any proposed geothermal or ground-coupled systems at any University location with the Office of Physical Plant, Engineering Services and obtain written consent to proceed prior to any further design development or installation. No geothermal or ground-coupled systems shall be installed at any University location without written approval of the Office of Physical Plant, Engineering Services.

C. Where approved, well systems shall be designed and constructed in accordance with 23 81 00.03.I and 33 20 00.

23 21 23 Hydronic Pumps

.01 Pumps

A. General

1. Standby pumps shall be provided for all hot water heating and chilled water circulating systems.

2. Pump schedules shall indicate system served, operation (Duty or Standby), gpm, pump head, rpm, motor horsepower, location, make and model number, and electrical characteristics.

3. A single pressure gauge with gauge cocks and interconnecting piping from the suction to the discharge sides of the pump shall be provided on each pump in order that either pressure can be observed from a single gauge.

B. Pumps - Closed Coupled

1. Closed coupled pumps are not permitted.

C. Pumps – Base Mounted

1. Pumps shall be electric-motor-driven, centrifugal, end suction, single stage pumps. Pumps shall be bronze fitted, with bronze impeller, with close grained semi-steel split casing (125 psi), provided with mechanical seals designed for operating conditions shown on the plans. Pumps shall be provided with sleeve bearings and oil reservoir.

2. Pumps shall have sleeve bearing, specially selected for quiet operation at 1750 rpm. Motor size shown on the drawing shall be the minimum acceptable. Nominal horsepower of the pump selected shall not exceed 115 percent of the brake motor hp under any conditions of pump load. Motor shall not exceed the nominal hp at the specified delivery and head.

3. Discharge increasers shall be concentric and located at pump discharge nozzle. Provide three-quarter (3/4) inch drain from each base plate to nearest floor drain.

4. End suction pumps shall be provided with suction diffusers equipped with strainers.

5. Pumps shall be selected so that the ratio of impeller diameter used, to the maximum diameter possible in the casing, shall not exceed .85. Provide a purge cock in the casing and gauge tappings in pump suction and discharge.

6. All piping connections to pumps shall be independently supported so that no strain is imposed on the pump casing.

7. Pumps to be installed on "slab-on grade" shall be mounted on a six (6) inch high concrete pad with anchor bolts. Grout space between pad and base to eliminate all voids. Pumps to be installed on supported slabs shall be provided with concrete inertia subbases with isolators.

8. Refer to Detail [23 xx xx .xx]. Details are not yet available in WEB-based manual.

D. In-Line Pumps

1. Pumps shall be centrifugal, single stage complete with motor, mechanical seals, bronze fitted, bronze impellers, dynamically and hydraulically balanced, flexible coupler with safety guard.

2. Pump motor shall be supported independently.

3. Refer to Detail [23 xx xx .xx]. Details are not yet available in WEB-based manual.

23 22 00 Steam and Condensate Piping and Pumps

.01 Steam Piping (In Building)

A. All steam piping shall be graded in the direction of flow, 1" in 40 ft. At all low points in the steam piping system a drip station shall be installed. Provide offsets and bends wherever possible to allow for expansion and to control pipe movement. Provide anchors and expansion joints as required.

B. Steam piping shall be black steel Schedule 40 ASTM A-53, Grade B. Use all steel valves for steam piping.

C. Joints 2" and smaller, screwed; 2-1/2" and larger, welded or flanged. All high pressure piping welded.

D. All steam pipe strainers and traps shall be removed and cleaned prior to acceptance by the University.

1. ALL CLEANING WORK IN THIS SECTION MUST BE WITNESSED BY THE DEPARTMENT OF GENERAL SERVICES (FOR DGS PROJECTS) AND UNIVERSITY INSPECTOR TO BE ACCEPTABLE.

E. Drip legs shall be a minimum 1/2 the size of the steam main 18" in length with blow down valve at the bottom. Trap line connection shall be located in the center of the drip leg.

F. Refer to 23 07 00 for Insulation.

.02 Steam Condensate Return Piping (In Building)

A. All steam condensate shall drain completely by gravity or be pumped. Steam pressure shall not be used to lift condensate after a trap.

B. All gravity return condensate lines shall be pitched 1" in 30' in the direction of flow.

C. All condensate return lines in buildings shall be Schedule 80 black steel, ASTM A-53, Grade B. Use all steel valves for condensate piping.

D. Joints 2" and smaller shall be screwed; 2-1/2" and larger shall be welded or flanged.

.03 Steam and Steam Condensate Specialties

A. Traps and strainers shall be installed with isolation valves, check valves, and telltale drain to facilitate cleaning, maintenance and to check proper operation of trap.

B. Provide all traps with a minimum condensate collection leg of 18".

C. For low-pressure drips, use float and thermostatic.

D. For high-pressure drips use thermodynamic traps.

E. For modulating service use float and thermostatic.

F. Pressure Reducing Valves

1. The Main Steam Pressure Control Stations shall consist of an air-operated diaphragm control valve and a remotely-adjustable external air-operated

pressure control pilot. Direct spring-operated valves and valves with steam pilots will not be accepted. Air lines shall be provided under BAS.

2. The diaphragm control valve shall have a flanged cast bronze body having a 250 psi pressure rating. It shall have hardened stainless steel trim with a stellited seat ring. The valve shall be single seated, and suitable for dead end service with a 250 psi pressure drip. It shall operate on a 0 to 22 psi air signal from the control pilot and be normally closed (air to open).

3. The air-operated pressure control pilot shall be of the differential type suitable for readjustment from a remotely-located air loading panel.

4. The pressure controller shall be capable of maintaining outlet pressure within plus or minus 1/2 psi when passing flow from zero to the maximum specified, regardless of gradual inlet pressure variations.

5. The Steam Pressure Controller shall consist of a diaphragm control valve, type DDL or GPK, and a control pilot, Type UDDV, and a remote panel loader, Type PPF, all as manufactured by the Leslie Company or equal by Spence or Sarce. Remote panel loader shall have integral filters or be proceeded by strainers.

6. Consideration shall be given to two-stage reduction when required by pressure and two-stage parallel reduction when required by varying load conditions.

7. All pressure-reducing valves shall have an ASME/National Board stamped safety valve set at the low pressure side maximum pressure, with sufficient relieving capacity for a fully open PRV and its bypass line, along with a pressure gauge on the low pressure side of the PRV. The safety valve shall be piped full size minimum to a safe point of discharge outside the building.

8. The safety relief vent for PRV's serving systems of different pressures shall be piped independently of each other to a safe point outside the building.

9. Refer to Detail [23 xx xx .xx]. Details are not yet available in WEB-based manual.

23 23 00 Refrigerant Piping

.01 Refrigeration (General)

A. Where water cooled condensing units are specified, cooling towers or evaporative condensers shall be utilized. Cooling water to waste systems are not permitted.

B. Where defrost units are required, they shall be electrically operated with adequate space provided to replace defrost elements. Defrost should not be limited to electrical units. In larger installations hot gas defrost is preferred.

C. Installations shall be provided with necessary protective devices including, but not limited to electric overload devices, low suction pressure cutouts (manual reset), high head pressure cutouts (manual reset), low lube oil pressure cutouts (manual reset), oil traps, crankcase heaters, and anti-recycling.

D. Systems shall be designed for 95°F outdoor ambient summer conditions and where winter operation is desired, 0°F conditions.

E. All installations shall be performed by qualified refrigeration mechanics.

F. Maintain manufacturer's minimum recommended clearances, including distances to any plant material.

.02 Refrigerant Specialties

A. Installations shall be complete with filters, dryers, sight glass, and thermostatically controlled solenoid valve for pump down operation.

B. Provide isolation valves at all specialties.

.03 Refrigerant Piping

A. Refrigerant liquid and suction piping shall be type "L", hard drawn.

B. Joints shall be made by brazing at a temperature greater than 900 degrees Fahrenheit. A nitrogen purge shall be maintained while brazing all joints. Copper-to-copper joints and copper-to-brass joints shall be made with 15 percent silver brazing alloy.

C. Main piping fittings for driers, sight glasses, expansion valves, and controls should be flare type fittings, when available.

D. Refrigerant system should be evacuated to 500 microns held for at least 24 hours under this vacuum prior to charging the system with refrigerant. The procedure must be witnessed by PSU representatives.

E. Double suction risers shall be employed on systems with capacity reduction and where required by lift.

F. Precharged lines are not acceptable for systems above 5 tons.

G. All refrigeration piping to be anchored with Hydra Zorb type anchors.

H. Refer to Details [23 xx xx .xx] and [23 xx xx .xx]. Details are not yet available in WEB-based manual.

23 25 00 HVAC Water Treatment

.01 Water Treatment

A. The Professional shall follow the University's water treatment guidelines found in The Design and Construction Standards 23 25 00 for a more complete description of the requirements for water treatment.

B. At University Park Campus, the University will supervise the introduction of the chemical treatment into the system.

C. The Professional shall discuss provisions of the chemical treatment program at Commonwealth Campus projects with the University.

D. All closed systems (hot water and chilled water) shall be provided with chemical treatment.

E. All open recirculating systems (cooling towers) shall be provided with chemical treatment.

F. All steam boilers shall be provided with chemical treatment.

G. Guidelines for the use of ethylene glycol will also be found in 23 25 00.

.02 Closed Systems Water Treatment (Hot & Chilled Water)

A. Equipment: All closed loops shall have a Bypass Feeder (Pot Feeder) piped into the circulation line, so that chemical treatment can be introduced into the system. Pot feeder shall be constructed of 10 gauge steel, minimum. Cap shall be a minimum of 4 inch in size and made of cast iron with Buna N seat ring. A flow indicator shall be installed to show indication of flow through the bypass feeder.

B. Equipment Installation: Bypass feeder shall be installed across the re-circulation pump to allow for a minimum 5 psi pressure drop. The discharge side of the pump shall be piped to the bottom of the feeder and the suction side piped to the top. This will allow an upward flow of material in the feeder. The shot feeder shall be located at least 12 inches off the floor, and manual ball valves shall be conveniently located near the bypass feeder to isolate and drain the bypass feeder.

C. Pre-operational Cleaner: All systems shall be flushed with water prior to chemical cleaning. Use water meter to fill, record, and tag (permanent tag) the system with the actual system volume. Chemical cleaner shall be added to remove grease, mill oil, organic soil, flux, iron oxide etc. All terminal control valves and valves at end of runs (“dead legs”) shall be opened so that cleaner is circulated through the whole system. After cleaning, all strainers shall be flushed, and strainer screens cleaned or replaced. Once closed loop is chemically cleaned, system shall be dumped and flushed with water so that all cleaning chemical is removed from the system.

D. Chemical treatment: Shall be an alkaline, buffered, nitrite-based corrosion inhibitor, maintained at proper levels to prevent corrosion to the system.

.03 Open Re-circulating Systems Water Treatment (Cooling Towers)

A. Equipment:

1. All towers (including Evaporative Condenser type Towers) shall be equipped with an automatic blowdown controller, *LMI*, model DC4000, or approved equivalent. Controller shall have flame retardant, molded TPFE housing and clear polycarbonate cover that can be secured with a padlock. Controller shall be capable of feeding chemicals 4 ways: Pulse, Percent of time, Limit timer, and Percent of bleed. Controller shall have LED indicators for all functions and shall have a 4 to 20 mA output. Controller shall be supplied with a flow assembly to include the conductivity probe as well as a flow switch. The flow switch shall be capable of preventing the controller from operating the blow down valve or feeding chemical if no flow is indicated. Flow assembly shall be able to be isolated by manual ball valves so that assembly can be repaired or replaced.

2. The fresh water make-up line to the tower shall have an electrical contacting water meter, Carlon, model JSJ, or approved equivalent. This water meter must be capable of sending an electronic pulse to the controller to allow the controller to feed chemical based on the volume of fresh water to the tower. The water meter shall be installed with a by-pass that is capable of being valved off so that water can still feed the tower and meter can be taken out for repairs.

3. Chemical feed pump shall be *LMI*, model P131-392SI, or approved equivalent capable of pumping 10 gal/day maximum. Pump shall be supplied with an integral anti-siphon/priming valve. All tubing shall be clear polyethylene. Pump shall be capable of modulating its stroke and speed. Pump shall have a liquid end construction of Polypropylene/Flourofilm/Polyprel.

4. If the condenser water volume is greater than 800 gallons, a solid halogen feeder (brominator) shall be installed to provide a controlled distribution of tableted, approved bromine and chlorine donors. The brominator shall have an integrally mounted flow meter for accurate feeding and manual valve with the capacity to adjust the flow from 0 to 5 gal/min. A pressure relief valve shall be used on those applications where the brominator is used on a pressure discharge or if the unit will be used in with conjunction with a solenoid and timer. For systems with less than 800 gallons, a simple water filter housing shall be provided for the feeding of the solid holagen.

B. Equipment Installation:

1. Blow down valve shall be installed so that the valve can be isolated by conveniently located ball valves so that blow down valve can be removed, repaired, and or replaced. A Strainer shall be installed up stream of the blow down valve to catch any dirt or debris that may prevent the blow down valve from functionally properly. Strainer shall be capable of easily being cleaned and replaced.

2. The chemical inhibitor shall be injected into an area of high flow and shall use an injection nozzle that has a check valve to prevent the flow of condenser water into the chemical injection line.

3. All new systems shall have a corrosion coupon rack installed, so that coupons can be used to help diagnose any potential corrosion problems. The

rack shall be located so that coupons can be easily removed and installed.

C. Pre-operational Cleaner: All condenser water systems shall be flushed with water prior to chemical cleaning. Use water meter to fill, record, and tag (permanent metal tag) the system with the actual system volume. Chemical cleaner shall be added to remove grease, mill oil, organic soil, flux, iron oxide etc. Once condenser water system is chemically cleaned, the system shall be dumped and flushed with water so that all cleaning chemical is removed from the system. After cleaning, all strainers shall be flushed, and strainer screens cleaned or replaced.

D. Chemical Treatment: Inhibitor shall be designed to control corrosion of all metals, as well as inhibit the formation of scale. The chemical inhibitor shall be a blend of organic inhibitors and dispersants that contain no molybate, zinc, or heavy metals. The use of the chemical inhibitor shall be in compliance with all local discharge regulations. The chemical treatment program shall maintain proper levels of chemical inhibitor to sustain a LSI of 2.5 to 3.0. PH of the condenser water shall not be below 8.0 and not exceed 9.5. Biocide program shall be limited to solid halogen feed chemicals. These chemicals shall be fed in a manor that prohibits the growth of bacteria, especially Legionella prevention.

.04 <u>Steam Boilers Water Treatment</u>

A. Equipment:

1. The fresh water make-up to the feed water tank shall be softened to remove calcium and magnesium particles from the water. The softeners shall be regenerated automatically based on a water meter. The unit shall be sized so that softener regenerates approximately twice per week.

2. The feed water tank shall be sized to allow for a minimum of 10-20 minutes residence time of the feed water to allow sufficient time for pre-warming of the feed water. The feed water tank shall be fitted with a stainless steel sparge line. The sparge shall be located on the bottom of the tank to allow for sufficient contact with the feed water. Holes in the sparge line shall be positioned to the center of the tank away from the tank walls. The oxygen scavenger shall be fed directly into the feed water tank below the water line with a Stainless Steel injection nozzle. The feed water tank shall have a factory-installed coating to help prevent corrosion on the tank walls.

3. A conductivity controller, *LMI*, model DC-4000, or approved equivalent shall be used to maintain conductivity limits within the boiler. Controller shall have flame retardant, molded TPFE housing and clear polycarbonate cover, which can be secured with a padlock. Controller shall have LED indicators for all functions and shall have a 4 to 20 mA output. The controller will actuate a motorized ball valve when conductivity reaches above the set point. The controller shall then close the motorized ball valve when the conductivity goes below the deadband. The controller must be easily calibrated and come with a high-pressure conductivity probe. Controller shall be provided with a motorized ball valve and globe valve to prevent flashing.

4. Two mixing tanks shall be provided: one for the dispersant and phosphate liquid chemical, another mix tank for the oxygen scavenger. The mix tank pumps shall be relayed to the feed water pump so they are both activated when the feed water pumps are on. Each mix tank shall have a mixer to allow suitable mixing of chemicals. The water for the mix tanks shall be soft water, and if possible from either condensate or feed water tank. Chemical pumps shall be sized to overcome the boiler pressure as well as pressure in the feed water line. All connections from the chemical pump to the point of injection shall be hard piped, with check valves to prevent the feed/boiler water being pushed back into the chemical pump.

5. Stainless Steel Injection nozzles should be used to feed chemicals into the feed water line (or feed water tank for the oxygen scavenger). The injection nozzle for the inhibitor shall be in the feed water line, and after the feed water pumps but as far as possible from the boiler. Each injection nozzle shall be installed with an isolation valve in case any repairs are needed to chemical feed system. Provide check valves on all chemical feed lines to prevent the feed water from pushing back into the chemical injection line.

B. Pre-operational Cleaner: (Boil out) All steam boilers shall to be flushed with water prior to chemical cleaning. Specially formulated, liquid boil-out solution containing inorganic and organic surfactant materials, iron sequestrates, and corrosion inhibitors shall be used. The product shall be designed to remove oil, grease, and mill scale from new boiler surfaces and shall clean water-side surfaces that have become contaminated with oil or grease during service.

C. Chemical Treatment: The dispersant and inhibitor shall be liquid blend of polymeric dispersants, phosphate conditioning agents for control of deposit formation and improved iron and sludge dispersion. Product shall be suitable for FDA/USDA regulated facilities. The dispersant shall be mixed and maintained in a poly mix tank with mixer and high-pressure pump. This pump shall be activated whenever the feed water pumps are turned on. These chemicals shall be injected into the feed water line down stream from the feed water pumps and as close to the boiler as possible. Oxygen scavenger shall be a powdered sodium sulfite, used to protect the feed water tank, piping and boiler from dissolved oxygen attack. The oxygen scavenger shall be mixed and maintained in a poly mix tank with mixer and pump. The pump shall be activated whenever the feed water pump is turned on. A check valve must prevent any back flow to the pump from the feed water tank.

.05 <u>Ethylene Glycol Systems</u>

A. Equipment: Glycol systems shall be equipped with a mix and fill tank with manual fill capabilities, hose bibb from domestic water for tank filling, and tank level alarm interconnected with the BAS.

B. Equipment Installation:

1. Do <u>not</u> direct-connect makeup lines to glycol systems.

2. Glycol systems should be configured so that small sections of the system can be isolated with valves and drained to a local floor drain. Alternatively, a tank should be installed at the glycol system fill point that is large enough to capture the entire system’s contents.

C. Pre-Operational Cleaning

1. All systems that are to be filled with a glycol solution shall be cleaned as outlined under “Closed Systems Water Treatment (Hot & Chilled Water)” above.

D. Chemical Treatment

1. Take reading of Glycol concentration in system. (Should be 25% if system is off during winter months 30% if system runs in the winter).

2. Shutdown circulation pumps prior to adding additional glycol.

3. Open air vents at top of system to allow air to escape as system fills.

4. Use Glycol pump and add Glycol mixture (25% or 30%) until desired pressure is achieved. (If correct pressure level is unknown, use 5 lb. Per floor as rule of thumb).

5. Turn on pumps and circulate system mixture.

6. ontinue to bleed air until system is free of air.

7. Close valves to air vents once all air is out of system.

8. Recheck Glycol concentration and system pressure. Add additional Glycol or water if needed to bring system to correct concentration level and correct pressure.

E. If you are not sure of proper fill procedures or how to determine correct concentration of mixture, please contact Mike Kelleher or one of the Environmental System technicians.

.06 <u>Side Stream Filters</u>

A. Closed Systems (Heating and Cooling)

1. All new closed circulating systems shall have a side stream filter. This shall include all heating hot water, chilled water, dual temperature, and glycol solution piping distribution systems.

2. Equipment: All closed circulating systems shall have a side stream filter piped into the circulation line, so that suspended solids can be removed from the system. All filters shall be bag filter type so that bags can be either taken out and cleaned and reused or replaced. All bags shall be 25-micron size. Filters shall be sized to handle a minimum of 10% of the system flow (gallons per minute) that the circulating pumps are capable of producing.

3. Filter Vessel: Material of construction shall be 304 Stainless Steel, with removable cap and swing-out bolts with eyenuts. Units shall be capable of 150 psi working pressure. Pressure gauges shall be mounted so that pressure can be read on both sides of the filter. Gauges shall be capable of showing pressures from 0-100 psi, unless a higher operating system pressure is required.

4. Filter Bags: Construction shall be polyester fiber, felt material. Bags shall be capable of operating temperatures between 275 – 325 °F. Bags shall be a standard size to fit into the filter vessel.

5. Equipment Installation: Filter shall be installed across the circulation pump to allow for a minimum of a 5 psig pressure drop across the filter unit. Manual valves shall be conveniently located near the filter to isolate, balance, and drain the filter. A ball valve shall be installed in the inlet pipe to the filter. A combination shut-off/balancing valve shall be installed in the discharge pipe from the filter, and set for 10% system flow at all times. The drain line shall be piped to the sanitary sewer.

B. Open Re-circulating Systems (Cooling Towers)

1. All new open circulating condenser water systems shall have a side stream filter.

2. Equipment: All open circulating systems shall have a side stream filter piped into the circulation line, so that suspended solids can be removed from the system. All filters shall be bag filter type so that bags can be either taken out and cleaned and reused or replaced. All bags shall be 100 micron size. Filters shall be sized to handle a minimum of 10% of the system flow (gallons per minute) that the circulating pumps are capable of producing.

3. Filter Vessel: Material of construction shall be 304 Stainless Steel, with removable cap and swing-out bolts with eyenuts. Units shall be capable of 150 psi working pressure. Pressure gauges shall be mounted so that pressure can be read on both sides of the filter. Gauges shall be capable of showing pressures from 0-100 psi.

4. Filter Bags: Construction shall be polyester fiber, felt material. Bags shall be capable of operating temperatures between 275 – 325 °F. Bags shall be a standard size to fit into the filter vessel.

5. Equipment Installation: Filter shall be installed across the circulation pump to allow for a minimum of a 5 psig pressure drop across the filter unit. Manual valves shall be conveniently located near the filter to isolate, balance, and drain the filter. A ball valve shall be installed in the inlet pipe to the filter. A combination shut-off/balancing valve shall be installed in the

discharge pipe from the filter, and set for 10% system flow at all times. The drain line shall be piped to the sanitary sewer.

C. Manufacturer

1. Filter Vessels: Filter Specialists, Inc.

a. BFN 11:

1) 2” inlet and 2” outlet
2) Uses one #1 bag
3) Maximum 100 GPM water flow

b. BFN 12:

1) 2” inlet and 2” outlet
2) Uses one #2 bag
3) Minimum 4.4 square ft bag surface area
4) Maximum 220 GPM water flow

c. BFN 13:

1) 1” inlet and 1” outlet
2) Uses one #3 bag
3) Minimum 0.5 square ft bag surface area
4) Maximum 25 GPM water flow

d. BFN 14:

1) 1” inlet and 1” outlet
2) Uses one #4 bag
3) Minimum 1.0 square ft bag surface area
4) Maximum 45 GPM water flow

2. Filter Bags: Filter Specialists, Inc.

a. Bag Size #1:

1) Minimum 2.0 square ft bag surface area
2) Minimum 2.1 gallon bag volume
3) 7” diameter x 16.5” long bag

b. Bag Size #2:

1) Minimum 4.4 square ft bag surface area
2) Minimum 4.6 gallon bag volume
3) 7” diameter x 32” long bag

c. Bag Size #3:

1) Minimum 0.5 square ft bag surface area
2) Minimum 0.37 gallon bag volume
3) 4” diameter x 8.25” long bag

d. Bag Size #4:

1) Minimum 1.0 square ft bag surface area
2) Minimum 0.67 gallon bag volume
3) 4” diameter x 14” long bag

.07 Water Analysis and Testing for Closed Loop Systems

A. The purpose of this procedure is to outline the steps used to test any closed re-circulating loops on campus, (chilled water, hot water, glycol, etc.). This procedure also outlines many implications of what might happen if a closed loop system is not properly chemically treated.

B. The following tests will be run on each closed loop:

1. Visual Inspection:

a. After taking a sample of the water, the water analyst will visually inspect the water and see how clear the water is. If the water is relatively clear the water analyst may continue with the remaining tests.

b. If the water appears cloudy and dark brown in color, the analyst will check to see if any filtration system is on the closed loop. If so, the filter may need to be changed or backwashed.

c. The analyst may choose to take a water sample and let it set for a couple of hours.

1) After the water sample had time to sit for a couple of hours, if the water starts to clear up and a deposit forms on the bottom of the container – this indicates the water contains high levels of suspended solids.

2) If a filter is not already on the system the analyst may choose to recommend installation of some type of filter to help clear up the water.

3) Suspended solid loading in a closed water circulating loop can lead to problems, the solids can settle out in low flow areas. The resulting deposit can cause corrosion and provide conditions that promote bacteria growth. Some bacteria can absorb the chemical inhibitors used to prevent corrosion, which will still leave the

system untreated, even though chemical has been added. Deposits can act as an insulator preventing good heat transfer. Not maintaining good heat transfer will increase energy costs to any system.

2. The analyst may choose to run an iron test using the Hach colorimeter based on the degree of water discoloration.

   a. The water analyst should record the readings so comparisons can be made to previous readings to help diagnose the system in the future.

   b. If the dissolved levels of iron are greater than 30 ppm, the analyst will recommend to have the system flushed and chemically cleaned.

   c. High levels of dissolved iron left in the system can lead to more corrosion problems, leaks, poor heat transfer efficiency, as well as bacteria problems.

3. Conductivity: Every system will have the conductivity measured.

   a. After reading the conductivity with the conductivity meter the analyst will record the current reading and review past readings. A conductivity reading higher or lower than the previous reading generally indicates a number of situations.

      1) If the conductivity reading is higher than previous readings, this indicates that something has been added to the system, for example the water analyst may have added chemical to the system during the last service. If chemical was not added and the conductivity has increased dramatically, the water analyst may need to check for potential areas of contamination. If conductivity is above 5000 mmhos, it may be recommended that the system be drained and refilled with treated water.

      2) Extreme levels of high conductivity can lead to some types of corrosion problems.

      3) If the conductivity reading is lower than previously recorded, this

indicates that some water was lost from the system. (Most likely the chemical inhibitor levels will be low as well). The water analyst may need to check with area maintenance to see if any work was done on the system to explain the water loss. If the closed system inhibitor (NT403) has been added and conductivity levels have not risen from the last visit, this may indicate the system has a continuous leak. If the conductivity levels remain low (approximately the same conductivity as the raw water), the analyst will need to check for leaks and report the problem to area maintenance.

4) Running at low conductivity may cause a number of problems. First, it is a huge waste of water, chemicals and energy. Secondly, it may damage equipment. Fresh water makeup brought into a leaking hot water boiler loop will deposit certain types of deposition on the boiler tubes. If the leak is not caught in time the tubes could fail and the boiler may need to be re-tubed. Leaks in a chilled water system can lead to scale build up in heat exchangers and chillers, lowering the equipment efficiencies and raising the Universities energy costs. It may also promote corrosion and may increase the chance of piping failures.

4. Nitrite Test: Each treated closed loop will be tested for Nitrite levels.

a. The water analyst will check past history of the nitrite levels for each system being tested. If nitrite levels are lower than what is required, the water analyst will add the appropriate amount of closed system inhibitor (GE Betz NT403) to the system. The water analyst should record the approximate amount of closed system inhibitor added to the system. Not maintaining the proper nitrite levels will lead to corrosion problems, which may require the system to be repaired or re-piped. It may also lead to iron oxide deposition in piping causing low flows and reduced heat transfer efficiencies.

b. If the nitrite levels remain low after adding the closed system inhibitor and conductivity has remained the same. The analyst may choose to run a bacteria test on the system in question by using the GE Betz BioScan.

1) If the readings for the closed system is above 25 RLU's the water analyst may request that the system be flushed.

2) If the water analyst discovers that the system does have a bacteria growth problem, he may choose to recommend the closed loop system be drained, refilled and treated with a closed system biocide as well as a bio-dispersant. After the system has circulated for a couple of days the system should be dumped and refilled with fresh water retreated with closed system inhibitor (GE Betz NT403).

3) Within 2 weeks of retreating, the water analyst should retest the closed loop system for bacteria levels again, to verify the bacteria growth problem is gone. Some bacteria can feed off the nitrite in the closed system inhibitor and will in turn promote corrosion was well as increase the chance of slimes and biomasses growing within the system. These bacteria could reduce the efficiencies of the equipment and could cause health and safety issues for employees and the general public.

c. If the nitrite levels are high, it is not recommended to drain the system. Rather, leave the system as is and record nitrite levels. Additional chemical will not hurt the system.

d. The analyst may choose to run a sulfate reducing bacteria test and may need to contact the GE Betz water treatment representative to do so.

5. PH Measurement: Every closed loop will have the pH tested and recorded.

a. The water analyst will review the previous pH reading s and see if any big pH swing is evident.

1) The pH of the closed loop should always be higher than the make up water pH.

2) The pH of a closed loop should never be below 7.0. If this ever arises, the closed loop should immediately be drained and retreated. Any pH below 7.0 is considered to be a corrosive environment.

3) It is important to have a properly calibrated pH meter. If the meter is not functioning properly the results may not be helpful in any system diagnosis.

b. If the pH reading has dropped dramatically from the previous service visit, it would indicate that there might be a bacteria growth problem. Refer to the Nitrite Testing section of this procedure for testing and dealing with the potential of bacteria growth.

c. If the pH reading is high (above a pH of 11) the system should be drained, refilled and retreated with closed system inhibitor. Certain types of corrosion can occur at high pH levels.

6. Glycol: Each glycol system should have the glycol measured using a refractometer.

a. This reading will indicate the level of freeze protection the closed loop is treated for.

b. If lower than what is required for the system, the water analyst will contact Central Services for glycol addition.

.08 <u>Water Treatment Control Limits</u>

A. Condenser Water

1. 6 to 9 ppm of Phosphonate
2. 0.5 to 1.0 ppm of Chlorine Residual
3. 2.5 cycles of concentration

B. Closed Loop Chilled Water System

1. 300 to 600 ppm of Nitrite

C. Closed Loop Hot Water System

1. 600 to 900 ppm of Nitrite

D. Glycol Systems

1. Systems operating in the winter: 30% solution by volume, (3° F freeze protection)
2. Systems not operating in the winter: 25% solution by volume, (10° F freeze protection)

E. Hot Water Boilers

1. 600 to 900 ppm of Nitrite

F. Steam Boilers

1. 30-60 ppm of Sulfite
2. 30-60 ppm of phosphate
3. 3000-4000 mmhos of neutralized conductivity

23 30 00 HVAC AIR DISTRIBUTION

23 31 00 HVAC Ducts and Casings

.01 Ductwork

A. General

1. Duct sizes shown shall be inside clear dimension.

2. Use ASHRAE and SMACNA guidelines.

3. Ductwork pressure classification shall be specified in the contract documents.

4. All metal ductwork shall be cross-broken to insure rigidity.

5. All rectangular elbows shall have double thickness turning vanes. The use of radius elbows with double thickness turning vanes over rectangular elbows is encouraged.

6. Every branch duct should be provided with an expanded take-off from the main duct. A manual balancing damper shall be installed at the take-off.

7. Fume hood exhaust duct work shall be specified for Type 316 welded or galvanized steel coated with PVS.

8. Fiberglass ductboard will not be permitted.

9. In ductwork carrying steam or high humidity, all seams shall be welded or sealed.

B. Manual Volume Dampers

1. Manual volume dampers shall be installed in all branch ducts for balancing and shall be indicated on the drawings. All balancing shall be done with branch duct dampers and not with diffuser dampers.

2. Dampers shall be opposed blade with adjustable quadrant and locking device with position indicator.

C. Access Doors

1. Hinged access door shall be installed at all automatic dampers, fire dampers, reheat coils and other apparatus requiring inspection and servicing.

2. Doors shall be suitable for the pressure classification.

3. Doors shall open against static pressure in duct.

4. Doors shall be fully gasketed and insulated when installed in insulated ductwork.

D. Flexible Connections

1. Flex connections shall be provided at connections to all moving equipment.

E. Flexible Ductwork

1. Flexible ductwork shall not exceed 6' in extended length.

23 33 00 Air Duct Accessories

.01 Fire Dampers

A. Fire dampers shall be installed where required by the International Mechanical Code and NFPA.

B. Temperature rating of fusible links shall be shown in the contract documents.

C. Frames shall be large enough so that there will be no obstruction to air flow when the dampers are open. Construction and arrangement of fire dampers shall be as approved in each case prior to installation. Access shall be provided for replacement of links and so labeled.

D. Fire dampers shall be approved by U.L. and so labeled and installed, shall comply with the requirements of NFPA 90A and the International Mechanical Code.

.02 Sound Attenuators

A. Refer to 23 05 01.05 Sound Pressure Level Requirements.

B. An analysis is required for both supply and return ductwork systems.

C. Drawings shall indicate velocity, S.P. loss, and db attenuation through all octave bands for each attenuator.

23 34 00 HVAC Fans

.01 Fans

A. Fans, except power roof ventilators, shall be provided with lubricating type bearings with extended fittings as required.

B. All fans, including roof fans, shall be belt driven with solid sheaves. For speed adjustments, the Contractor shall provide required sheaves and pulleys to meet specified CFM. Band belts shall be used when multiple V-belts are required.

C. Fume hood exhaust fans shall have acid resistant coating, two (2) coats air dried "Heresite" or equal. Design static shall not be less than one (1) inch S.P. Spark resistant is required for explosive atmosphere. Where design conditions do not permit the use of coatings, discuss requirements with the University.

D. Fan schedule on drawing should be very complete, giving area served, fan location, method of control, performance characteristics. Controls must not be placed in public areas. If fans are interlocked, schedule shall indicate the unit the fan is interlocked with.

E. Fan ratings shall be AMCA certified.

F. All fans shall be statically and dynamically balanced and run tested at the factory.

G. Belt guards: Where required, guards shall be constructed of expanded metal mesh to allow for quick visual inspection of belts and pulleys without removal. Guards shall be attached to equipment with hinges and/or quick release fasteners that can be turned without tools to allow for ease of maintenance.

23 36 00 Air Terminal Units

.01 VAV Boxes

A. University Park applications - VAV boxes shall be supplied without the manufacturer's controller or air flow sensor.

B. VAV Box schedule shall include minimum and maximum cfm's, NC levels, and coil ratings.

C. When multiple boxes are used to serve a single zone, all shall be controlled from a single thermostat.

D. Location of all boxes shall be accessible for maintenance.

23 37 00 Air Outlets and Inlets

.01 Air Terminal Devices (Diffusers, Registers, Grilles)

A. The Professional shall require as part of the shop drawing submission:

1. The air terminal submittal shall include a complete tabulation of all devices identified by room number and listing the model, velocity, cfm, throw, pressure drop, sound level and flow factor and/or core area in square feet.

2. The submittal shall also include the manufacturer's recommendations for air balancing procedures for the devices submitted.

B. Specify aluminum in damp or wet atmospheres.

C. Panel diffusers are not permitted.

D. Perforated supply diffusers are not permitted.

E. Linear diffusers are preferred for VAV systems.

23 38 00 Ventilation Hoods

23 38 16 Fume Hoods

.01 Fume Hood Exhaust Systems

A. All systems shall have an adequate supply of make-up air tempered to room temperature. Auxiliary air hoods shall not be used. Total make-up air quantity shall not exceed that required to maintain the specified pressure relationship for the space.

B. Exhaust fans serving fume hoods shall be located at the discharge end of the system. For additional information see Division 11 53 13 - Laboratory Fume Hoods.

C. Exhaust fans shall discharge a sufficient height above the roof level to provide safe discharge and dilution of hazardous chemicals. System design shall meet ANSI/AIHA Z9.5.

D. Duct systems and fans serving hoods used with combustible materials shall be of spark-proof construction.

E. Use Type 316 stainless steel (welded), FRP or PVC. Suitability of duct material shall be verified with the University.

F. Hoods, fans, and discharges shall be tagged for type of service and location of hood and fan. Fume hoods shall be tagged to match serving fan tag.

G. Exhaust fans and ductwork handling toxic fumes and/or radioisotopes shall have a self-adhering CAUTION sticker attached.

H. Exhaust stacks shall be designed according to the latest edition of the ASHRAE Fundamentals Handbook, Airflow Around Buildings.

23 40 00 HVAC Air Cleaning Devices

23 41 00 Particulate Air Filtration

.01 Air Filters

A. Filters for comfort systems serving offices, classrooms and other non-critical areas shall be 30% efficiency throwaway filters.

B. Filters for systems serving critical lab areas, animal rooms and special areas will be dictated by the project requirements. The Engineer shall review specific requirements with the University.

C. Filters shall have separate holding frame with side access and slide out frames properly sized in accordance with filter manufacturers' guidelines. Frames shall be located to permit removal of entire frame for filter replacement.

23 50 00 CENTRAL HEATING EQUIPMENT

.01 Combustion Safeguards

A. All fuel burner combustion safeguards on gas-fired boilers over 100 HP and oil-fired boilers over 50 HP should be Factory Mutual approved equipment.

B. Drawings, including section details of wiring and gas train, along with a Factory Mutual Application for acceptance form, shall be submitted to Factory Mutual for review and acceptance prior to installation.

C. Final approval is based on a satisfactory field test of completed installation.

D. Gas fired unit heaters up to 400,000 BTUs need AGA approval.

23 57 00 Heat Exchangers for HVAC

.01 Heat Exchangers

A. Plate and frame heat exchangers shall typically be specified in water to water and steam to water applications.

1. Heat exchangers shall be of bolted construction with heavy duty frame heads.

2. Plates shall be of 316 stainless steel construction and shall be gasketed to prevent cross contamination.

B. Shell and tube heat exchangers may be used if plate and frame units are inappropriate for the application.

1. Converters shall have steam in the shell and water in the tubes. Tubes shall be 90-10 cupro nickel, ASTM B-111, and velocity shall be less than five (5) feet per second.

2. Provide sufficient clear space to allow for tube bundle removal. (No less than the entire length of the converter.)

3. Tube bundles shall be straight tube design. A spare tube bundle shall be provided as part of the contract.

C. ASME rating is required.

D. A relief valve sized at not greater than the heat exchanger's maximum working pressure shall be installed on the water side of each steam/hot water heat exchanger. Since PA L&I currently considers chilled water heat exchangers to be unfired pressure vessels, provide relief valves on both the building chilled water side and campus chilled water side. The relief valves must be installed at the heat exchanger and prior to the isolation valves. The relief valve should be sized by the design professional.

E. Install vacuum breakers in piping for modulating steam supply and minimum 18" drip leg to trap inlet.

F. Converters shall be selected at 2 psig steam supply and .0005 fouling factor. Control valves shall be sized for a steam entering pressure of 8 psig with a 6 psi maximum drop through the valve.

23 60 00 CENTRAL COOLING EQUIPMENT

23 64 00 Packaged Water Chillers

.01 Water Chillers (General)

A. Discuss chiller selection at conceptual design stage with the University.

B. Where the cooling load exceeds one hundred tons, consider the feasibility of installing centrifugal chillers.

C. Basis of design shall include models from a minimum of two reputable manufacturers. Specify maximum acceptable sound levels.

D. Allow sufficient clear space equal to length and width of machine for tube pull clearance.

E. Discuss refrigerant selection with the University prior to equipment selection. Chillers using chlorofluorocarbons (CFCs) as a refrigerant are not acceptable.

F. Provide beam with minimum 4' clearance above chiller or allow sufficient clear space above and around machine for utilizing gantry for compressor replacement.

G. Refer to 23 05 01.01 for motor inrush current and voltage drop requirements.

H. Mechanical rooms containing chillers shall be designed to meet the requirements of ASHRAE Standard 15.

I. Refer to Detail [23 xx xx .xx] for piping. Details are not yet available in WEB-based manual.

23 65 00 Cooling Towers

.01 Cooling Towers (General)

A. In general, specify units of galvanized steel construction with PVC fill. Cooling towers may be similar to the Baltimore Air Coil "V" line.

B. Indoor sumps should be considered where winter operation is required. When towers are required to operate in the winter, sump heaters and heat tracing of piping shall be specified.

C. The Professional shall consult the University during the design phase and seek approval of the location of all cooling towers.

D. Select towers at 77°F W.B.

E. Provide fan shaft pull space at ends of tower.

F. See 23 25 00.03 for Cooling Tower water treatment.

G. Maximum acceptable sound levels shall be included in the specification. Sound levels shall be appropriate for the location and take into account any local noise ordinances.

H. Condenser water temperature control shall be provided by a bypass valve unless an alternate control scheme is reviewed and approved by the University in advance.

I. Cooling tower fan speed control shall be specified unless the use of constant speed fan control is reviewed and approved by the University in advance.

Belt guards: Where required, guards shall be constructed of expanded metal mesh to allow for quick visual inspection of belts and pulleys without removal. Guards shall be attached to equipment with hinges and/or quick release fasteners that can be turned without tools to allow for ease of maintenance

23 70 00 CENTRAL HVAC EQUIPMENT

.01 Air-Handling Equipment (General)

A. Fans and motors on 5 tons and larger shall be on a common isolation base or rail unless internally isolated by the equipment manufacturer.

B. When available, permanently lubricated bearings shall be used, minimum 200,000 hour life. On others, extended lube shafts with 1/8" steel tubing and flush plugs with relief set at 5 psig, shall be specified.

C. All fans 3/4 hp and above shall be Class II fans.

D. Fan shafts shall be solid. Adequate fan shaft pull space must be provided.

E. Dampers shall have edge seals, low leakage (2%) type.

F. All components shall be accessible via access doors and removable panels.

G. Freeze protection shall be provided on all 100% outdoor air equipment. (Double trap steam coils.)

Belt guards: Where required, guards shall be constructed of expanded metal mesh to allow for quick visual inspection of belts and pulleys without removal. Guards shall be attached to equipment with hinges and/or quick release fasteners that can be turned without tools to allow for ease of maintenance.

.02 Central Station Air-Handling Units

A. Schedules should be complete with area served, location, total and sensible cooling capacities, entering and leaving temperatures (air and water) for all coils, motor hp, voltage, heating capacities, steam pressure, steam coil condensation rate, fan rpm, total air quantity, outside air, external and internal static pressures.

B. Fans shall be statically and dynamically balanced, non-overloading centrifugal type.

C. Double wall, insulated casings and plenums shall be specified for all units including those serving heat and vent applications.

   1. All fan sections shall have a perforated inner wall.

D. Casings for heat and vent applications shall have space for installation of future cooling coil.

E. Units shall be installed to allow removal of all coils, filters, and fan shaft. Provide full finned width of coil on one side of the unit to facilitate removal.

F. Units shall be mounted on vibration isolators, unless internally isolated by the manufacturer and placed on a 6" concrete housekeeping pad.

G. Units shall have mixing box and filter box or combination filter/mixing box properly sized so as not to exceed filter manufacturers recommended face velocities. Provide low leakage dampers (2%) for mixing box dampers.

H. All coils shall be air vented and arranged for proper drainage.

I. Steam coils shall be piped to prevent freeze-ups. This shall include vacuum breakers and 18" drip leg to trap inlet which may dictate that units be mounted on angle iron frame above housekeeping pad.

J. One hundred percent (100%) outdoor air preheat coils shall be steam distributing type with external face and bypass control. Coils shall be double trapped.

   1. Do not use valve control for preheat application.

   2. Review other heating mediums with University when steam is not available.

K. Provide flexible connectors in all piping and ductwork.

L. Air blending devices shall be installed on all central station air-handling units.

.03 Energy Recovery Units

A. Consider for areas with high exhaust rates and 100% outdoor air systems.

B. Submit cost analysis and control sequence for approval prior to submission of final review drawings.

23 80 00 DECENTRALIZED HVAC EQUIPMENT

23 81 00 Decentralized Unitary HVAC Equipment

.01 Packaged Rooftop Equipment

A. The Professional shall obtain permission from the University before designing packaged rooftop units for University projects.

B. Air cooled packaged air-conditioning equipment shall be equipped with low ambient controls to permit operation to 0°F.

C. Rooftop package air conditioners 5 tons and larger shall be mounted on structural steel channel curbs with curb isolation rails. Smaller units may be mounted on manufacturers' prefabricated curbs.

D. Submit details and catalog cuts of unit prior to design. Units must be manufactured for that application.

.02 Packaged Heat Pumps

A. Use of air cooled packaged heat pumps on University Park Campus are not permitted.

B. When considered for use on Commonwealth Campus, prior approval must be received and 100% auxiliary heat must be provided.

.03 Water-Source Heat Pump Systems

A. Evaluate and select systems and equipment for lowest 30 year life cycle cost. Refer to Design Phase Submittal Requirements, “Design Phase” Section, paragraph B.1. Also refer to Design and Construction Standards, Introduction, Paragraph K and 230001.01 Owner General Requirements and Design Intent.

1. Consider extra high efficiency units with 2 stage compressors and ECM fans whenever appropriate to achieve energy efficiency goals and improved part load performance, including reduced cycling of compressors.

2. Select refrigerant type for least environmental impact and best long term economic benefit.

3. Where close dehumidification control is needed for the application, use technologies that avoid simultaneous heating and cooling mechanical

energy. Hot gas reheat or wrap around heat pipe may be viable options.

4. Minimize pump energy use with variable flow pumping controls whenever justified by lowest life cycle cost.

   a. Systems shall be designed to include means to ensure proper flow to each unit within allowable ranges as overall system pressure and flow fluctuates without objectionable noise or maintenance nuisances.

B. Large quantities of decentralized terminal units with DX refrigeration systems and filters are undesirable in large scale projects due to extensive, multiplied maintenance requirements.

C. Dedicated outside air systems to supply preconditioned and dehumidified fresh air are required to adequately maintain zone relative humidity within acceptable ranges for indoor air quality and to minimize risk for mold growth.

1. Experience has shown that areas served by terminal cooling units with constant volume and occupied continuous fan operation and supplied with untreated OA as a rule have problems with inadequate dehumidification.   When compressors cycle off when space temperature is satisfied, any moisture condensed on the coil during the on cycle is re-absorbed back into supply air. This problem is worsened by short cycling due to cooling loads lower than design maximum, which is most of the time. Very serious high humidity problems occur when space has low cooling load and outside air conditions are cool and humid.

2. Refer to economizer requirements elsewhere for spaces that will have year round cooling requirements.

D. Mechanical equipment requiring routine access for inspection and maintenance such as fans, compressors and filters shall be located in mechanical spaces with sufficient working clearances maintained. Refer to Coordination requirements in 230001.50

E. Free delivery type units with compressors and fans located within areas served are prone to objectionable noise levels. Therefore, they are not acceptable in noise sensitive areas such as classrooms, conference rooms, and sleeping areas. Refer to Vibration and Sound Control requirements in 230501.05.

F. Maintain at least a minimum deadband of 20 degrees in the condenser water temperature control(per IECC) between minimum setpoint(enabling heat addition) and maximum setpoint (enabling heat rejection).

1. Be sure to insulate piping that will carry fluids below 55 degrees F or otherwise where condensation may occur due to transporting fluid at temperatures lower than ambient indoor dewpoint.

G. With low temperature loop temperature, the use of high efficiency condensing boilers is a viable option. However, special care must be taken to ensure acidic condensate will be neutralized and operating staff must be properly trained to keep it maintained in perpetuity in order to not harm plumbing systems.

H. Preferred method of heat rejection is open cooling tower (induced-draft type with VFD fan speed control), remote indoor sump, tower loop pump, plate and frame heat exchanger (or shell and tube with marine type headers that allow easy end removal for inspection and cleaning without disturbing the piping system) and a constant pressure, centrifugal solids separation system.

1. The first cost of this combination is relatively close to the cost of the closed circuit fluid cooler with all required freeze protection methods. In addition, operating costs are lower because no heat is lost from the loop in the winter, winterization/freeze protection is minimized and less power is required for cooling tower fans.

I. Ground-Source Heat Pump systems shall, in addition to all of the above, meet the requirements listed below:

1. Refer to associated ground coupled heat exchanger (well field) requirements in 232113.08 and 332000.

   a. Test wells: In addition to the geological information required, the test well data shall include empirical thermal conductivity values that can be used to optimize the well field design.

2. Design and installation of ground-source heat pump systems shall comply with industry best practices in accordance with the following publications:

   a. ASHRAE: Ground Source Heat Pumps – Designing Geothermal Systems for Commercial and Institutional Buildings, current edition.

b. International Ground Source Heat Pump Association (IGSHPA):

1) Closed Loop Ground Coupled Installation Guide,
2) Slinky™ Installation Guide,
3) Design and Installation Standards,
4) Grouting Procedures for GHP Systems,
5) Soil and Rock Classification Field Manual,
6) Grouting for Vertical Heat Pump Systems

3. Antifreeze solution, if required, shall be non-toxic and have low environmental impact to minimize risk in the event of uncontrolled fluid loss through the well field to the ground/groundwater. Ethanol formulated for commercial antifreeze solution and Propylene Glycol appear to be relatively non-hazardous and are presently the only options acceptable to the University. Ethanol has slightly better heat transfer and lower pump energy characteristics and estimated lower solution costs of those two options.

23 82 00 Convection Heating and Cooling Units

.01 <u>Air Coils</u>

A. Separate drain pans for each cooling coil shall be provided.

B. Access doors shall be provided on upstream side of all coils.

C. Clearance shall be provided for the full finned width of coil for removal.

D. Cooling coil face velocities shall not exceed 500 fpm.

E. Air vents shall be provided at highest point.

F. Hose end drain valves shall be provided with isolation valves.

G. Vacuum breakers shall be provided on all steam heating coils.

H. Water coils shall be piped in counter-flow configuration.

I. When installing coils in a corrosive atmosphere, appropriate corrosion resistant coating shall be provided, i.e., fume hood run-around loops.

J. Refer to Details [23 xx xx .xx], [23 xx xx .xx], and [23 xx xx .xx]. Details are not yet available in WEB-based manual.

.02 Heating Terminal Units (General)

A. Provide isolation valves on each item.

B. Design for average hot water temperature of 190°F or 1 psig steam supply. Size steam control valve for 8 psig inlet pressure and 6 psi maximum drop through the valve.

C. Design drawings shall indicate all selection criteria.

D. Finish shall be submitted with color chip for approval.

E. Refer to Details [23 xx xx .xx] and [23 xx xx .xx]. Details are not yet available in WEB-based manual.

.03 Finned Tube Radiation

A. Use sloped top style enclosure.

B. Use commercial grade enclosure. Residential grade enclosure not permitted.

C. Controls (See 23 09 00).

.04 Fan Coil Units

A. Do not use four or five port control valves.

B. Fan speed control shall not be used. Select units at high speed and use valve control for space comfort.

.05 Unit Ventilators

A. When installed in hydronic systems without glycol, units must have manual reset freezestat to (1) shutdown fan, (2) close outdoor air damper, and (3) open heating valve.

B. Motors shall be three speed with unit-mounted selector switch.

23 83 00 Radiant Heating Units

.01 Radiant Heaters

A. Consider only for areas with high ceiling and low ventilation areas.

B. Do not use in office areas.

23 84 00 Humidity Control Equipment

.01 Humidifiers

A. The steam source must be from building steam whenever possible.

1. Electronic steam generators to be used only when building steam is not available.

2. Water softening equipment shall be provided when electronic steam generators are used.

3. Provide two changes of canisters.

B. Follow manufacturers' guidelines for location.

C. Provide access panel with a glass vision panel on downstream side of manifold.

D. Controls (See 23 09 00).

E. Refer to Detail [23 xx xx .xx]. Details are not yet available in WEB-based manual.

.02 Dehumidifiers

A. Small packaged dehumidifiers shall be arranged so condensate is piped to sanitary system.

DIVISION 26 – ELECTRICAL

26 00 00 ELECTRICAL

26 00 01 Owner General Requirements and Design Intent

.01 General

A. Service Voltage

1. At University Park, service shall be provided from the 12,470V distribution network whenever possible. The 4,160V network may be used where adequate capacity exists with approval of ES (Engineering Services).

2. At other locations, services may be provided by a local utility or the campus distribution network as appropriate. Details will be provided by Engineering Services.

3. Identify any medium voltage (600V and greater) raceway system within a building by painting it red in its entirety.

B. Building Voltages

1. For loads greater than 750kVA, consider 480Y/277V distribution with 208Y/120V step down transformers for receptacles and other 120V loads.

2. Step down transformers shall be located in rooms with adequate fire ratings and transformers connected for sound isolation using flexible conduit, isolation pads and when supported from the building steel, spring hangers.

C. Utility Demand and Consumption

1. The Design Professional shall complete the Utility Demand and Consumption form on all projects. It is used to inform the University of the impact on the distribution system capacity. Submit to Engineering Services at the Preliminary Design review submission and at the Final Design submission.

D. Specification Editing

1. Generally, use the “listed manufacturers” option in lieu of “available manufacturers.” Confirm any manufacturer preference with Engineering Services.

2. Note at least 3 manufacturers, unless otherwise approved.

3. Confirm Requirement for extra materials with Engineering Services. Typical items to provide are occupancy sensors, specialty luminaire lenses, fuses, indicating lamps, and enclosure keys.

E. Mounting Heights

1. Heights are measured to device centerline, unless otherwise noted.

2. Mount switches, card readers, and similar devices at 44” AFF.

3. Mount receptacles and similar wiring devices at 18” AFF.

.02 LEED

Refer to the PSU LEED Policy for our sustainable design philosophy. Refer to the PSU Green Buildings web page for additional information.

.10 Scope (Basis of Design/Application of Systems)

A. Motors

1. Motors less than 3/4 hp. shall be single phase, 115 volts for operation on 120-volt circuits. Motors 3/4 h.p. and larger shall be three phase. Motors operating on three phase, 208V shall be rated at 200V. Motors operating on three phase, 480V shall be rated at 460 volts.

2. On motors 25 hp and above at 480V or 10 hp and above at 208V, discuss the use of soft start and variable speed drives. Voltage sag exceeding 3% on motor start is unacceptable. Download and edit the Variable Frequency Drive specification from Engineering Services.

3. Where reduced voltage starters of the wye-delta type are used, only closed transition types are acceptable.

B. Elevator Service and Support Circuitry

1. Service:

a. Where required by code, service to elevator machine shall be derived from an alternate source of power, in addition to the normal source. Alternate sources of power shall be reviewed with Engineering Services for selection.

b. Provide fusible disconnect switch in the machine room to feed the elevator motor controller.

c. Alternate source transfer switch shall contain SPDT contacts for central control system and sufficient number of poles to switch phase wires. Refer to Transfer Switch requirements.

d. Shunt Trip:

1) Where required by code, elevator service shall include a self-contained, fusible shunt trip machine disconnect, Bussman Powermodule, or approved equal, installed in machine room as required by code.

2) Where elevator machine service includes an alternate source transfer switch, and shunt operator is required, the shunt trip circuit shall originate from a normal/ emergency circuit. Shunt trip normal / emergency circuit shall include a voltage-sensing, time delay on release (off) relay, field set for seven (7) second delay to off. Relay shall include NC contact for tie-in to fire alarm panel to annunciate “trouble”. Discuss optional methods of alarm with Engineering Services where tie-in to fire alarm system is not possible.

2. Support Circuitry:

a. Cab lighting: Dedicated 20A Life Safety circuit shared only with emergency telephone consolidator. Fuse the cab lighting disconnect at 20A, slow-blow fuse. Coordinate dual cab lighting requirement with Engineering Services.

b. Emergency Phone Consolidator: Dedicated 20A Life Safety circuit shared only with elevator cab lighting. Fuse emergency phone disconnect at 5A, fast-acting fuse. Request further emergency phone installation design requirements from Engineering Services.

c. Pit Sump Pump: Dedicated circuit and devices as required by load.

d. Hoistway lighting and GFI receptacle: Dedicated 20A normal circuit for GFI receptacle(s) and required lighting fixtures. Provide two (2) 2-lamp 48 inch shallow depth (4 inches or less) lensed T8 luminaires in the pit and one at each landing above the pit. Mount luminaires vertically in a corner, except pit luminaires may be horizontal. Provide separate 3-way switching for hoistway luminaires (in pit and top of shaft). Mount all devices higher than 24 inches AFF in the pit.

e. Machine Room lighting and GFI receptacle: Dedicated 20A standby power circuit for GFI receptacle and lighting. Connect lighting and related control on line side of GFI receptacle.

.20 Definitions

A. Provision(s)Electrical space that is built for installation of future overcurrent device without the requirement of any additional parts

.30 Submittals

A. Design Calculations

The University requires that the Design Professional submit calculations for all projects, including:

1. Illumination
2. Short Circuit
3. Voltage Drop

B. Construction Submittals

1. Engineering Services has the right to request any submittal for review, but it is the sole responsibility of the Design Professional to approve or reject that submittal. Do not mark any item “Approved As Noted – Pending PSU Review” (or similar). Discuss any questions or concerns with Engineering Services prior to returning the document to the contractor.

2. Require all submittals in PDF format so that they may be shared electronically.

3. Provide a submittal schedule to ES and include ES on any transmittal of review comments.

4. Contact ES regarding which, if any, submittals should be transmitted for review. Again, this review shall be simultaneous to that of the Design Professional.

.40 Standard of Quality/Quality Assurance (reserved)

.50 Coordination (reserved)

26 01 00 Operation and Maintenance of Electrical Systems

.01 General

A. It is the goal of PSU to design systems that are safe, robust, and easy to maintain. At University Park, all major electrical equipment is inspected, tested, and maintained on a yearly basis.

26 05 00 Common Work Results for Electrical

26 05 10 Electrical Acceptance Testing

A. The Design Professional shall consider utilizing the information below to create a separate “Electrical Acceptance Testing” specification. It is acceptable to include these testing requirements within other specification sections, but these requirements are often overlooked by the contractor. A separate section clarifies the requirement to hire an independent testing agency for all electrical testing.

.01 Electrical Acceptance Testing

A. Testing shall be performed on electrical equipment and systems to assure that equipment and systems are operational and within applicable standards and manufacturer’s tolerances. Testing should verify that equipment and systems are installed in accordance with design specifications. All testing shall occur at the building site.

B. Testing shall be performed by an independent organization that is professionally independent of the manufacturers, suppliers, and installers of the equipment or systems being evaluated. The name of the proposed testing organization shall be submitted to Engineering Services for approval.

C. Qualified technicians who are trained and regularly employed for testing services shall do all testing. Submit technician qualifications.

D. The testing organization shall conform to the general guidelines of section 5 of the latest NETA Acceptance Testing Specifications, in their entirety. This includes the following:

   1. Safety and Precautions
   2. Suitability of Test Equipment
   3. Test Instrument Calibration
   4. Test Report

E. Provide report in the Megger "Power DB" program. Furnish one (1) original, editable electronic (.mdb format), one (1) electronic PDF copy, and Four (4) paper copies of the completed report to Engineering Services.

F. Notify Engineering Services at least seven (7) days in advance of any testing. A representative of Engineering Services shall witness testing.

G. Inspection and testing of all applicable electrical equipment listed below shall be done in accordance with the latest version of NETA ATS. This will include all tests marked optional unless waived in writing by Engineering Services.

   1. Switchgear and Switchboard Assemblies
   2. Transformers: Air Cooled and Liquid Filled
   3. Cables: Low and Medium Voltage
   4. Air Switches:

      a. Low Voltage
      b. Medium Voltage, Metal Enclosed
      c. High and Medium Voltage, Open

   5. Oil Switches: Medium Voltage
   6. Vacuum Switches: Medium Voltage
   7. Low Voltage Circuit Breakers:

      a. Insulated Case/Molded Case (100 amp frame and larger)
      b. Power

   8. Medium Voltage Circuit Breakers:

      a. Air
      b. Oil
      c. Vacuum
      d. SF6

   9. Circuit Switchers
   10. Network Protectors
   11. Protective Relays
   12. Instrument Transformers
   13. Metering
   14. Grounding Systems
   15. Ground Fault Protection Systems
   16. Motors: AC and DC

17. Generators: AC and DC
18. Motor Starters: Low and Medium Voltage
19. Motor Control Centers: Low and Medium Voltage
20. Adjustable Speed Drive Systems

21. Direct Current Systems:

    a. Batteries
    b. Battery Chargers

22. Surge Arresters

    a. Low Voltage Surge Protection Devices
    b. Medium Voltage Surge Protection Devices

23. Capacitors and Capacitor Control Devices
24. Outdoor Bus Structures
25. Emergency Systems:

    a. Engine Generator
    b. Uninterruptible Power Systems
    c. Automatic Transfer Switches

26. Automatic Circuit Reclosers and Line Sectionalizers
27. Fiber Optic Cables

.02 System Function Tests

A. Perform system function tests upon completion of equipment tests as defined in 26 05 10.01. It is the purpose of the system function tests to prove the correct interaction of all sensing, process, and action devices.

B. Verify the correct operation of all safety devices for fail-safe functions in addition to design function.

C. Verify the correct operation of all sensing devices, alarms, and indicating devices.

.03 Thermographic Survey

A. Perform a thermographic survey on all current carrying devices. Perform the survey during periods of maximum possible loading and prior to expiration of warranty or bond period.

B. Imaging equipment shall be capable of detecting a minimum of 1-degree Celsius at 30 degrees Celsius.

C. A level 2 certified thermographer shall perform the survey.

D. A report shall be submitted to Engineering Services which includes the following:

1. Description of equipment tested
2. Discrepancies
3. Temperature difference between area of concern and reference area
4. Areas inspected
5. Load conditions at time of inspection
6. Provide photographs and/or thermograms of deficient areas
7. Summary which includes recommendations for corrective actions.

.04 Electromagnetic Field Testing

A. Determine the vector-valued quantity of magnetic flux density for power frequency magnetic fields over a predetermined space or area, as designated by Engineering Services.

B. Testing shall be done in accordance with the latest version of NETA ATS.

.05 Voltage Drop Testing

A. A voltage test shall be made at the last receptacle of each branch circuit of each Panelboard. Total voltage drop shall not exceed 5% of the initial voltage measured at the end of that branch circuit. The test shall be made using a 12A load attached to the furthest receptacle.

B. Documentation of the results shall be provided to Engineering Services.

C. Any non-conforming branch circuits shall be corrected.

.06 Fire Alarm Testing

A. All connected fire alarm devices are to be tested for operation, proper programming, and verified to meet proper sequence of operation. Printout of full system test showing test of all devices and interconnected systems shall be provided. Test is to include all sprinkler flow sprinkler tamper devices, all duct detectors and associated fan shutdown, any smoke evacuation sequence, elevator recall, magnetic door hold or door closer devices, any fire alarm sub-system interconnection, etc. Final fire alarm testing is to be completed in the presence of a representative from the Office of Physical Plant – Engineering Services with sufficient prior notification.

B. System shall be tested for code compliant alarm audibility upon completion of construction.

C. Completed and accurate As-Built floor plans shall be used for final testing and copies of these drawings shall be turned over to the PSU representative immediately after testing. These plans shall include full floor plans showing all fire alarm devices with address and/or loop ID information. Also, a copy of the MXL program shall be turned over to PSU at that time.

26 05 13 Medium-Voltage Cables

.01 Primary Cables

This work is typically installed by PSU Utility Services. Discuss medium voltage cable installation with Engineering Services.

26 05 19 Low-Voltage Electrical Power Conductors and Cables

.01 Cabling

A. Minimum wire size shall be #12 AWG.

B. Provide separate neutral conductor for every interior branch circuit.

C. Utilize solid conductors for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

D. Service Entrance, Feeders, and Branch Circuits: Single conductors in raceway, minimum 75C rated. MC cable is not acceptable.

E. All exterior wiring connections, and those made at or below grade shall be waterproof with UL listed waterproof connectors.

26 05 26 Grounding and Bonding for Electrical Systems

.01 General

A. Contact Engineering Services for a copy of the basic PSU grounding connections detail.

B. Provide a common bare copper main ground bus, wall mounted adjacent to the service entrance equipment. Bus should be minimum 1/4 inch by 2 inch by 24 inches long, mounted on insulators. Confirm final bus sizing with Engineering Services.

C. Exothermically weld the connection between the service entrance equipment and the ground bus at each end. Identify each connection to the ground bus with an engraved nameplate. Run bare copper cable (minimum 1/0) from bus to ground rod bed. Make bolt-on connections at ground bus as follows:

1. Water service
2. Ground rods (minimum 3-rod bed, spaced at least rod length apart, buried at least 12 inches below grade)
3. Building steel
4. Telecom ground bus(es)
5. Lightning protection system (when provided)
6. Step-down transformer(s) within the main electrical room (when provided)

D. Any connections made below grade shall be exothermically welded.

E. Ground resistance in reference to physical earth connection shall be below levels as follows:

1. Systems below 500kVA – 10 ohms
2. Systems between 500 and 1000kVA – 5 ohms
3. Systems above 1000kVA – 3 ohms
4. Systems serving Data Center Equipment - 3 ohms
5. Point to point grounding resistance between main grounding bus and all major electrical equipment frames – 0.5 ohms

F. All conduits carrying conductors shall have a ground wire.

G. Provide separate ground wire from ground bus to telephone equipment room. Refer to 27 05 00 Communications for required size.

H. Do not run ground conductors from service transformer to service entrance equipment.

I. Isolated ground systems must be approved by Engineering Service.

26 05 29 Hangers and Supports for Electrical Systems (reserved)

26 05 33 Raceway and Boxes for Electrical Systems

.01 General

A. Minimum size 3/4 inch.

B. Lighting runouts may be 1/2 inch flexible metallic conduits, no longer than 72 inches.

C. Aluminum and plastic conduit is not acceptable (interior). Use of rigid PVC conduit within corrosive environments is acceptable. Review use of PVC with Engineering Services.

D. Intermediate grade, rigid steel, and EMT conduit are acceptable. Where EMT is used, compression fittings are required. Metal or Armored cable is not acceptable, except in small lengths as final connections to luminaires, motors, or as approved by Engineering Services.

E. Install No. 12 non-ferrous or 200 lb. test nylon fish line in conduits where permanent wiring is not installed.

F. Support outlet boxes and switch boxes from two (2) adjacent studs. Outlet boxes designed to attach to one metal stud and be "sandwiched" between the front and back layers of Gypsum Wallboard are not allowed.

G. Where installed in fire-rated partitions, apply firestop putty pads or similar fire rated products on or around outlet boxes as required to maintain the fire rating of the partition.

H. Back-to-back outlets in commons walls are not permitted. Outlet boxes shall be separated by at least one stud wherever possible. In cases of outlet boxes of adjacent rooms in the same stud cavity at the same height, provide a layer of expandable spray foam insulation around each box in that cavity. There must be a minimum of a 1” horizontal separation space between boxes of adjacent rooms. If this condition occurs in a fire rated wall, provide a 1 hour fire rated putty pad to cover the back of the outlets of one side of the partition. Other junction box installations on fire rated walls shall comply with UL requirements.

I. Surface mount raceway, when approved by Engineering Services, shall typically be non-metallic with dual channels similar to Wiremold 5400 series. Specify appropriate metallic raceway when required to resist certain chemical environments.

26 05 36 Cable Trays for Electrical Systems

.01 Cable Trays

A. Acceptable for communication cable. Refer to the PSU TNS (Office of Telecommunications and Network Services) Minimum Standards for Telecommunications Facilities for requirements.

B. May be desirable in certain research laboratories or facilities to contain equipment power and control cable.

26 05 43 Underground Ducts and Raceways for Electrical Systems

.01 Underground Ducts

A. Underground primary cables shall be installed in 5-inch PVC conduit encased in concrete. Conduit may be NEMA TC-6 Type EB or Schedule 40. Elbows shall be Schedule 40.

B. Underground secondary cables shall be installed in 4-inch PVC conduit encased in concrete. Conduit may be NEMA TC-6 Type EB or Schedule 40. Elbows shall be Schedule 40.

C. Steel reinforcing is required under traffic areas. All concrete-encased duct banks shall be installed such that a minimum 3"-thick base is poured and cured prior to setting base spacers.

D. Add the following requirements to any ductbank detail.

1. “Avoid over-excavation of the ductbank trench. Ductbank walls shall be formed within 5 feet of a manhole, within a “common” utilities trench, and if the width of the pour will extend beyond the dimension shown on the detail.”

2. “Inspection and sign-off by University representative is required after the ductbank base is poured and the conduits are installed, but prior to final concrete encasement.”

E. Contact Engineering Services for typical CADD details.

.02 Manholes and Transformer Foundations

A. Electric manholes shall be precast or poured in place with pulling irons and cable supports. Coordinate size with ES.

B. Manholes shall be fitted with nonlocking type heavy frame and cover. Provide minimum 32" clear access opening. The word “ELECTRIC” shall be cast in the cover in three (3) inch high letters. The opening shall be in one corner. A non-conductive ladder extending to the surface shall be provided.

C. Transformer foundations base shall be precast, coordinate size with ES. Base and lid shall have tongue and grove seal.

D. Factory bell ends are to be used where conduits penetrate manhole/foundation walls.

E. Grounding:

1. All electrical systems shall be suitably grounded, including all non-current carrying metallic components of all equipment and metallic conducts. Grounding shall be accomplished as required by the National Electric Code.

2. Transformer foundation shall have a minimum 2/0 AWG bare copper ground ring with at least two (2) 96" ground rods. Exothermically weld rods and ring. Ring shall be a minimum of 24" from the edge of the foundation, buried between 18" and 24" deep. Rods shall be installed at opposite corners or at a distance of more than rod length apart. Extend cabling a minimum of 48" above grade for connection to transformer. Do not connect this ground ring to the building service.

F. Supports in Electric Manholes:

1. The Contractor shall furnish and install supports in new and existing manholes where cables are to be installed, cable rack supports of the type permitting variable vertical location of the cable supports. Supports shall be installed as required to support newly installed or relocated cables. Each cable shall be secured to each cable support. Nonmetallic support systems may be used provided they are warranted for labor and materials for a period of no less than two years.
2. All cables shall be properly dressed and racked on the support arms around the walls of the manholes providing adequate slack for future rearrangement and splicing. Existing ducts must not be blocked by cables.

G. Work within manholes must comply with the PSU Physical Plant Confined Space Entry requirements and permission obtained from the Utility Electrical Supervisor to insure safe entry procedures are followed. Due care shall be taken not to damage existing cables.

H. Contact Engineering Services for typical CADD details.

26 05 48 Vibration and Seismic Controls for Electrical Systems

.01 General

A. Refer to section 1613 of the latest IBC (International Building Code) to confirm any requirement for seismic restraint. Discuss requirements with Engineering Services prior to proceeding with design.

26 05 53 Identification for Electrical Systems

.01 General

A. All nameplates shall be fastened by rustproof screws.

B. Panel directories shall denote their source of power.

C. Utilize Engineering Services naming scheme for mechanical equipment, exterior lighting fixtures, etc.

D. Refer to 26 27 26 Wiring Devices for Class 1 Critical Research labeling.

E. Direct the contractor to use an indelible marker to inscribe panel and circuit number on the back of each coverplate and provide a durable tag inside the outlet box.

F. Color for 208/120V Circuits:

1. Phase A: Black.
2. Phase B: Red.
3. Phase C: Blue.

G. Color for 480/277V Circuits:

1. Phase A: Brown.
2. Phase B: Orange.
3. Phase C: Yellow.

H. Provide emergency power warning sign per NEC 700, as required.

I. Label all electrical equipment.

1. Direct the contractor to use and indelible marker to inscribe panel and circuit number on the back of each device coverplate and provide a durable marking inside the outlet box. Coordinate further labeling of receptacles with Engineering Services.

2. Distribution Equipment Designations

a. Distribution Equipment:

MDS	Main Distribution Switchgear (Switchboard)
SDS	Secondary Distribution Switchboard (typically a major piece of 208Y/120V equipment)
MDP	Main Distribution Panelboard
EDP	Emergency Distribution Panel (for distribution from generator)
SBDP	Standby Distribution Panel

b. Panelboards:

Branch

C	Critical (Legally Required Emergency)
E	Life Safety (Code Required Emergency)
_	Normal
O	Emergency Only
Q	Equipment (for some generator systems)
S	Standby (Non-Required Emergency)

Voltage

H	480Y/277V
L	208Y/120V

Type

B	Lab (include lab designation)
D	Distribution Panel
E	Life Safety (Code Req'd Emergency)
L	Lighting
M	Mechanical
R	Receptacle

Building Floor

0	Basement
1	First
2	Second…
P	Penthouse

Building Area (as required)

A, B, C...

Panel Sequence (as required)

a, b, c…
or
1, 2, 3…

c. Examples

"HL0a"	Normal power, 480V, Lighting panel, Basement (no building area, first in sequence)

“QHM2B”	Equipment branch, 480V, mechanical panel, 2nd Floor, area B (no sequence)

26 05 73 Engineering Power Studies

.01 General

A. Short circuit Studies, Protective Device Evaluation Studies, Protective Device Coordination Studies and Flash Protection Studies shall be performed by the distribution equipment manufacturer or an independent firm currently involved in high and low voltage power system evaluation. The study shall be performed, stamped and signed by a registered professional engineer in the State of Pennsylvania. Credentials of the individual(s) performing the study and the background of the firm shall be submitted to the Engineer for approval prior to start of the work. A minimum of five (5) years experience in power system analysis is required for the individual in charge of the project.

B. The studies shall be submitted to Engineering Services prior to receiving final approval of the distribution equipment shop drawings and prior to release of equipment for manufacture. If formal completion of the studies may cause delay in equipment manufacture, approval from Engineering Services may be obtained for a preliminary submittal of sufficient study data to ensure that the selection of device ratings and characteristics will be satisfactory.

C. The studies shall include all portions of the electrical distribution system from the normal power incoming primary source or sources, the emergency and standby power source or sources, down to and including all panels and distribution equipment in the distribution system, and as required to comply with NFPA 70E. Normal system connections and those which result in maximum fault and/or arc flash conditions, shall be adequately covered in the study.

D. The firm performing the study shall demonstrate capability and experience to provide assistance during start up, as required.

E. The power system studies are required to confirm the adequacy of the ratings of all electrical system components and proper coordination settings of all circuit breakers. These studies shall not be used as a basis to compromise the electrical system and do not imply that short circuit ratings of distribution equipment and devices may be lower than those indicated on the drawings or specified herein.

F. The power distribution equipment manufacturer shall carry in their bid to the Electrical Subcontractor, a sufficient allowance to provide modifications to the equipment, if necessary, based on the results of the studies identified herein.

G. Perform all studies using SKM Systems Analysis software, or approved equal by one of the following:

1. EDSA Micro Corporation
2. ESA Inc.

H. Submit an electronic copy of the final study in the format used to perform the study. Convert and submit in SKM format also.

.02 Coordination Study

A. Perform coordination study to support the selection of instrument transformer ratios, protective relay characteristics and settings, fuse ratings, low-voltage circuit breaker ratings, characteristics, and settings.

B. The study shall demonstrate that the protective devices as selected and set will ensure that the minimum unfaulted load is interrupted when protective devises isolate a fault or overload anywhere in the system while satisfactory protection is provided for equipment against overloads, and short circuits are interrupted as rapidly as possible.

C. Provide technical characteristics, manuals, time characteristic curves, etc. for each protective device along with the calculations used in preparing the study to Engineering Services. Report shall be in paper as well as editable electronic format. Electronic copy shall be compatible with SKM Systems Analysis software.

.03 Fault Current Study

A. The short-circuit current available on the primary feeder will be given to the Professional by Engineering Services.

B. Calculate the maximum available short-circuit current in amperes rms symmetrical at circuit-breaker positions of the electrical power distribution system. The calculation shall be for a current immediately after initiation and for a three-phase bolted short circuit at each of the following:

1. Switchgear and switchboard bus.
2. Medium-voltage controller.
3. Motor-control center.
4. Distribution panelboard.

5. Branch circuit panelboard.
6. Other equipment as required.

.04 NFPA 70E (Arc Flash Analysis) Study

A. Calculate Arc-Flash Incident Energy (AFIE) levels and flash protection boundary distances.

B. The Arc-Flash Hazard Analysis shall be performed in conjunction with a short-circuit analysis and a time-current coordination analysis.

C. Results of the Analysis shall be submitted in tabular form, and shall include device or bus name, bolted fault and arcing fault current levels, flash protection boundary distances, personal-protective equipment classes and AFIE levels.

D. The analysis shall be performed under worst-case Arc-Flash conditions, and the final report shall describe, when applicable, how these conditions differ from worst-case bolted fault conditions.

E. The Arc-Flash Hazard Analysis shall be performed in compliance with IEEE Standard 1584-2002, the IEEE *Guide for Performing Arc-Flash Calculations*.

F. The Arc-Flash Hazard Analysis shall include recommendations for reducing AFIE levels and enhancing worker safety.

G. The Arc-Flash Hazard Analysis shall include the proper settings for arc flash reduction maintenance switch(es), if specified on the project. Provide settings to avoid nuisance tripping.

H. The proposed vendor shall demonstrate experience with Arc-Flash Hazard Analysis by submitting names of at least ten actual Arc-Flash Hazard Analyses it has performed in the past year.

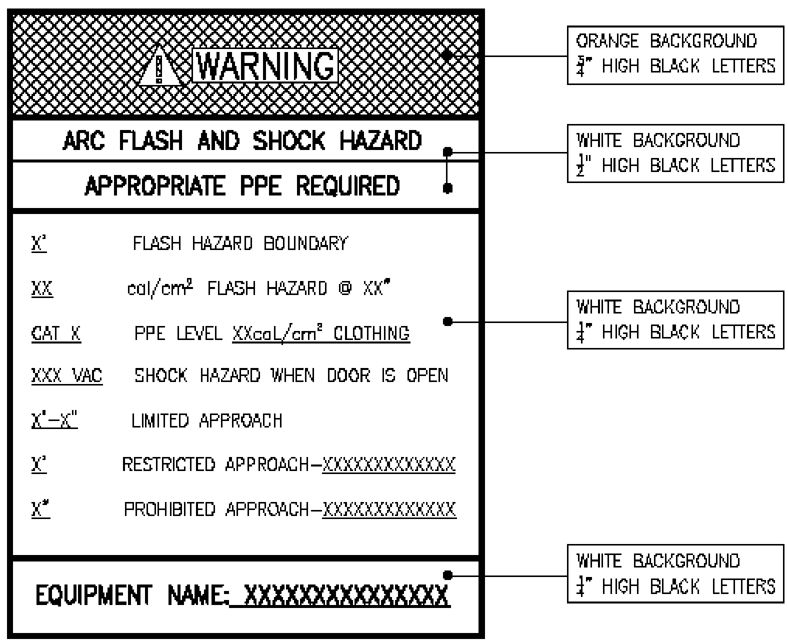
I. The proposed vendor shall demonstrate capabilities in providing equipment, services, and training to reduce Arc-Flash exposure and train workers in accordance with NFPA 70E and other applicable standards.

J. The proposed vendor shall demonstrate experience in providing equipment labels in compliance with NEC-2002 section 110 and ANSI Z535.4 to identify AFIE and appropriate Personal Protective Equipment classes.

K. Engineer shall specify or provide study on all major electrical distribution equipment and downstream distribution and utilization equipment. This shall include, but not be limited to:

1. Substation(s), switchgear, and switchboards
2. Distribution panelboards
3. Lighting and appliance panelboards
4. Motor control centers
5. Disconnect switches
6. Controller equipment such as variable frequency/adjustable speed drives
7. Fuses and circuit breakers
8. Rotating equipment
9. Batteries
10. Generator(s)
11. Automatic transfer switches
12. Feeders

L. Provide proper labeling per NFPA 70E on all noted equipment. Coordinate study and labeling requirements with Engineering Services. Typical minimum label requirements shown below:



Label shall be orange and include the date of the study. Specify a second blue label to note arc-reduction levels, when using arc-flash reduction feature.

26 09 00 Instrumentation and Control for Electrical Systems

26 09 23 Lighting Control Devices

.01 General

A. Intent – PSU designs shall strive for simple and effective methods of lighting control that is robust and easy to maintain.

B. Lighting Controls:

1. Interior building corridor, office, storage, individual restroom, and similar spaces shall be controlled via occupancy sensors (wallbox, wall mount, or ceiling mount). Use “vandal-resistant” models for wallbox mounting in individual bathrooms and small public rooms. Use dual-switch models for offices and similar spaces requiring dual level lighting (switch closest to the door frame controls the low-light level). Dual-technology is typically preferred, but consider whether the use of one technology over another is more appropriate. When ceiling sensors are used, other than in corridors, provide switch(es) on the load side to allow some user control. Building with individual HVAC control of offices shall use sensors with output relays to allow the HVAC unit to shut down to minimum levels when no occupancy is sensed. Discuss control strategy with Engineering Services at schematic design phase.

2. Interior building lighting of common spaces and certain “Night” lights shall be controlled through motorized circuit breakers (refer to Controlled Breaker Panels section of 26 24 00) via occupancy sensors and per schedule set by CCS (Central Control System). Provide timed override stations for certain spaces that may be occupied after normal business hours. Refer to the “Interior Public Space Lighting” section of the BAS (Building Automation System) Specification for further information.

3. Exterior building mount “Night” lights shall be controlled through motorized circuit breakers (refer to Controlled Breaker Panels section of 26 24 00) via the Central Control System. Refer to the “SITE/NIGHT LIGHTING” section of the BAS Specification for requirements.

4. Exterior “Site” (walkway, roadway, and parking) lights shall be controlled from the CCS (Central Control System) via motorized circuit breakers, utilizing CT’s to confirm circuit activation. In

lieu of motorized breakers, contactors and CT's may be used for buildings that would not otherwise require a motorized breaker panel. Refer to the "SITE/NIGHT LIGHTING" section of the BAS Specification for requirements and discuss options with Engineering Services.

26 09 26 Lighting Control Panelboards

Refer to 26 24 00 Controlled Breaker Panels for information.

26 10 00 MEDIUM-VOLTAGE ELECTRICAL DISTRIBUTION

26 11 00 Substations

26 11 16 Secondary Unit Substations

.01 General

A. Indoor unit substations may be required under certain designs. Where used, these shall be three-phase units equipped with a loadbreak fused switches, with current limiting fuses. SF6 gas insulated equipment shall not be used unless approved by Engineering Services.

B. Taps, two at 2-1/2% and each alone and two at 2-1/2% each below normal shall be provided.

C. Where indoor transformer rooms are used, they must be adequately ventilated with powered ventilators, dampers, and a suitable control system.

26 12 00 Medium-Voltage Transformers

.01 Distribution Transformers

A. This work is typically installed by PSU Utility Services. Discuss medium voltage pad-mount transformer project requirements with Engineering Services.

B. Provide transformer foundation for exterior locations. Ground per "Grounding" section below.

C. Indoor oil-filled transformer, when approved by Engineering Services, shall be FM approved (not just the oil itself). Contact Engineering Services for minimum efficiency requirements.

D. Where fuses are used, a complete set of spare fuses shall be provided.

E. Provide complete information, instructions, wiring diagrams and manuals for maintenance and servicing.

.02 <u>Grounding</u>

A. All electrical systems shall be suitably grounded, including all non-current carrying metallic components of all equipment and metallic conducts. Grounding shall be accomplished as required by the National Electric Code.

B. Provide minimum 2/0 AWG bare copper ground ring with at least two (2) 96″ ground rods around transformer foundation. Exothermically weld rods and ring. Ring shall be a minimum of 24″ from the edge of the foundation, buried between 18″ and 24″ deep. Rods shall be installed at opposite corners or at a distance of more than rod length apart. Extend cabling a minimum of 48″ above grade for connection to transformer. Do not connect this ground ring to the building service.

26 20 00 LOW-VOLTAGE ELECTRICAL DISTRIBUTION

.01 <u>General</u>

A. Services (480V and below)

1. Equipment shall be fully rated, series rated is not acceptable.

2. Provide a set of “as-built” drawings stored in the main electrical room. Storage shall be in a PVC tube mounted to the wall with caps on each end. Label tube appropriately.

3. Provide 30”x42”, laminated copy of the one-line diagram(s) adjacent to the service entrance equipment. Mount in aluminum frame under plexi-glass.

4. Consider using a SPD (surge protective device) on lighting/appliance panels. Review this with Engineering Services.

5. Contact Engineering Services for a list of acceptable equipment manufacturers.

6. All busing and wiring is to be copper. Specify that all lugs are to be copper, no aluminum is allowed due to failure from over-torquing.

7. Perform and submit voltage drop and short circuit studies. Voltage drop study shall size feeders utilizing a load equal to 80% of the overcurrent device rating. Engineer shall size feeders for a maximum 2% voltage drop. Engineer shall also provide information on each Panelboard advising the contractor as to the maximum length of a #12 AWG and #10 AWG branch circuit feeding a 12 A load to maintain no more than an additional 3% voltage drop. Short circuit study shall utilize the feeder sizes as determined by the voltage drop study.

8. Coordinate the requirement for panic hardware on door(s) exiting the main electrical room with the architect. When required, provide true panic bar setup to allow egress without use of hands, in case of electrical burns.

9. Indicating lamps on any equipment shall be LED.

10. When temporary power for a construction site is fed from a building with ground fault protection, the temporary power feeder shall be fed from a breaker with ground fault detection.

11. Electronic trip units with display must have integral power supply. Main/tie/main gear shall have dual power supplies with interconnection in tie section. Power supply must be multi-tap, capable of running on 120/240 VAC, and 48/24 VDC.

12. All circuit breakers of frame sizes from 100 amperes up to 400 amperes shall incorporate adjustable magnetic trip. Breakers 400 amperes and larger shall incorporate electronic trip units with functions as determined by the coordination study and as required by NEC. Breaker shall have cause of trip indicator targets. Trip units that utilize battery backup, shall have field replaceable batteries. Provide 20% spare batteries as well as full function secondary injection portable test set.

13. Provide Coordination Study, per the Engineering Power Studies section.

B. Service Entrance Equipment

1. Where Unit Substation is approved, provide secondary main overcurrent protection.

2. Ground fault protection – provide where required by the National Electric Code. When the main circuit breaker has ground fault protection, all second level breakers must also have ground fault protection. When a third level breaker equals or exceeds 400 amps, consider additional ground fault

protection. Consult with Engineering Services. Properly interlock all levels of ground fault protection to insure tripping at the lowest possible level and verify on the Coordination Study required under the Engineering Power Studies section.

a. Annunciate breakers with ground fault trip capability for a ground fault trip and include a ground fault trip indicator.

b. 208V systems shall not have ground fault breakers in the secondary distribution system except as required by code.

3. Designs for PSU shall strive to provide the lowest possible arc flash incident energy. Consider the use of arc flash light/current sensing system or separate arc reduction circuitry switch for use during maintenance and inspection of the service entrance equipment. Alternative arc flash reduction methods will be considered. When utilized, the arc reduction switch system shall adjust the trip curve of the breaker relay. Systems utilizing "zone-interlock" exclusively are not acceptable. Arc reduction maintenance system shall have remote lockable switch(es) on the front of the gear to initiate this setting. When this circuitry is provided, monitor the activation via CCS (Central Control System), per the BAS Specification.

4. Refer to 26 27 13 Electricity Metering for requirements.

5. Refer to 26 35 33 Power Factor Correction Equipment for requirements.

6. Refer to 26 43 13 Surge Protective Devices for Low-Voltage Electrical Power Circuits for SPD requirements.

26 22 00 Low-Voltage Transformers

.01 General

A. As the Base Bid, provide high efficiency copper-wound transformer(s) meeting US Department of Energy proposed Candidate Standard Level (CSL) 3 efficiency, with extremely low no load losses, similar to PowerSmiths "E-Saver-C3", Cutler-Hammer "HMT", Mirus International Inc. Ulltra, or others as approved by Engineering Services. Specify a deduct alternate for copper-wound, 115C rise, K-4 rated standard TP-1 transformers.

1. Once bids have been received, the consultant shall perform a life-cycle cost analysis based upon

loading profiles as agreed to with Engineering Serices base upon the building occupancy.

2. Low-loss transformers shall be designed to an efficiency standard higher than NEMA TP-1, the lowest legal efficiency for the following purposes:

   a. Delivering lowest life cycle cost according to the US Dept. of Energy

   b. Contributing to LEED Energy & Atmosphere Credit 1 (Optimize Energy Performance)

B. Require submission of efficiency data as follows:

   1. No load and full load losses per NEMA ST20
   2. Linear load Efficiency data @ 1/6 load
   3. Linear load Efficiency data @ 1/4, 1/2, 3/4 & full load
   4. Linear Load Efficiency @ 35% loading tested per NEMA TP-2
   5. Efficiency under K7 load profile at 15%, 25%, 50%, 75%, 100% of nameplate rating.

C. Maximum no load losses of Low-loss transformers shall not exceed:
   1. 15kVA: 60W
   2. 30kVA: 99W
   3. 45kVA: 130W
   4. 5kVA: 180W
   5. 112.5kVA: 260W
   6. 150kVA: 330W
   7. 225kVA: 450W
   8. 300kVA: 560W
   9. 500kVA: 850W
   10. 750kVA: 1200W

D. Efficiency at 1/6 load shall meet or exceed:
   1. 15kVA: 96.6%
   2. 30kVA: 97.4%
   3. 45kVA: 97.7%
   4. 75kVA: 98.2%
   5. 112.5kVA: 98.4%
   6. 150kVA: 98.5%
   7. 225kVA: 98.5%
   8. 300kVA: 98.6%
   9. 500kVA: 98.7%
   10. 750kVA: 98.7%

E. Require on-site revenue class efficiency and harmonic measurements of transformer once installed and operating. Data shall be collected from the primary and secondary sides of the transformer simultaneously on a synchronized cycle by cycle basis. The use of two discrete meters is not acceptable Primary and secondary readings shall to be synchronized to ensure accuracy. A performance report shall be issued by a licensed professional engineer. On large projects, sample at least 10% of the transformers on the project, as selected by Engineering Services.

26 23 00 Low-Voltage Switchgear

.01 General

A. Refer to Service Entrance Equipment in 26 20 00 for additional requirements.

B. Circuit breakers for lab facilities or of capacity 1,600 amperes and greater (and as required by Engineering Services for maintenance purposes) shall be of the metal enclosed low voltage power circuit breaker type, draw-out, with "Engaged," "Test", and "Disengaged" positions, to meet ANSI C37/UL1558. Racking shall be accomplished with cell door closed and latched. Each breaker cell shall be completely separated from adjacent cells. Provide each cell with protective shutter for personnel protection when breaker is racked out. Provide pad-locking provisions for all cubicles, including spaces. Primary contacts shall be field replaceable. Breakers shall have visual trip indicators. Coordinate feeder breaker types with Engineering Services.

C. Provide vertical barrier between adjacent upright sections to prevent arc event from traveling through the rear of the lineup.

D. Provide the following for any electrical equipment with draw-out breakers:

1. Overhead-circuit-breaker lifting device, track mounted, at top front of the gear.

2. Storage cabinet, with padlock and hasp, for storing equipment and breakers. Unit shall be 60”H x 24”D x 36”W, capable of 900lb/shelf built by Durham, Lyon, Stronghold, or approved equal.

3. Floor mount rolling hydraulic foot-pump platform lift, Beech Engineering (Division of Miller Products Inc.) Model CH-2470, or approved equal by Genie, Vestil, or Wesco. Rated load of 400lbs., minimum lift height of 68", and platform measuring a minimum of 20"X20".

E. Main-tie-main setup, when approved by Engineering Services, shall be electrically operated. The control sequence shall allow for automatic and/or manual transfer between sources (typical set up is for open tie with automatic transfer to available source with manual re-transfer). If provided with Kirk key interlock, include an extra “maintenance” key. “Maintenance” key shall be provided in a pad-locked box in the main electrical room and shall be properly labeled. Consider adding synch-check relay to allow for closed transition under engineering supervision.

F. Provide one (1) spare breaker in each frame size and at least 10% fully provisioned space capacity.

G. Provide mimic bus on large and/or complicated equipment. Normal power shall be in white, emergency shall be in red.

H. Provide hinged doors, front and rear. Rear doors shall have hasp for padlock. Label rear doors to match the front.

I. Padlocks, provide Best #11B772-L, with core #1C7F1-626, in quantity as follows:

1. One (1) for each rear hinged section
2. One (1) for each draw-out breaker cubicle and cubicle space
3. Two (2) spare

26 24 00 Switchboards and Panelboards

26 24 13 Switchboards

.01 General

A. Refer to Service Entrance Equipment in 26 20 00 for additional requirements.
B. Provide hinged doors, front and, as applicable, rear. Rear doors shall have hasp for padlock. Label rear doors to match the front.
C. Provide vertical barrier between adjacent upright sections to prevent arc event from traveling through the rear of the lineup.
D. Provide at least one (1) spare breaker in each frame size and at least 10% fully provisioned space capacity.

26 24 16 Panelboards

.01 General

A. Refer to Service Entrance Equipment in 26 20 00 for additional requirements.

B. Provide “door-in-door” hinged front cover.

C. Panels shall have complete bus and mounting hardware requiring only the installation of additional breakers for future expansion.

D. Allow 20% spare and another 10% fully provisioned space capacity for future breakers. Critical operations, shops and research facilities may require 50 percent spare capacity, consult with Engineering Services.

E. Distribution Panels

   1. Consider second level of SPD, especially if panel feeds sensitive or critical loads or has branch circuits running outside of the building footprint (site lighting, etc.).

   2. When ground fault is provided on the service entrance equipment, specify ground fault sensing and shunt-trip for breaker(s) feeding site lighting panel(s). Coordinate setting of ground fault to limit nuisance tripping, but also prevent any overtrip.

F. Branch-Circuit Panels

   1. Group installed panelboards shall have separate trim.

   2. All circuit breakers in utilization panelboards shall be of the bolt-on type.

   3. Panelboards serving dedicated computer loads shall be reviewed for 200% neutral bus and feeder application with Engineering Services.

   4. Specify that the electrical contractor shall coordinate final room name and numbering with Engineering Services prior to submitting panel schedules for approval. Circuits feeding exterior lighting shall utilize the 3-letter labeling scheme as directed by Engineering Services.

   5. Panelboard Installation:

      a. Panels serving loads in only one room may be located in that room.

      b. Panels serving more than one room shall be located in an electrical closet, corridor, or other accessible space.

      c. Do not install panelboards in janitor closets or dedicated telecom rooms.

      d. Where flush panelboards are used, install a one-inch conduit for every three spare poles to a point above the suspended ceiling.

e. Specify green ground wire with all circuits.

G. Controlled Breaker Panels:

1. Utilize motorized control circuit breaker panel(s) in lieu of contactor/relay panel(s) for control of interior and/or night and/or exterior lighting loads. Panels must have the ability for each type of load to be switched on or off manually.

2. Specify that the outdoor lighting circuits also be controlled via a Hand-Off-Auto switch(es) mounted to the side of the panel (for maintenance crews to check for dead lamps/ballasts). Depending on the project, this could include switches for “Building Mount”, “Walkway”, “Parking” and/or “Roadway” zones.

3. Provide any panel feeding exterior loads with SPD.

4. Acceptable manufacturers are Cutler-Hammer Pow-R-Command PRC100, Siemens i-3 Lighting Panel with I/O controller, or Square D Powerlink G3 3000 Level. Panel shall communicate via the BACnet protocol and includes an astronomic timeclock. The panel will also require a data connection and programming by a manufacturer representative so that if communication is lost, the system operates in a stand-alone mode (site and building mount exterior luminaires "ON" 30 minutes before dusk and then "OFF" 30 minutes after dawn; other lighting schedule as arranged with PSU).

5. Specify that a compact laptop computer be provided for lighting controls revisions for most new buildings and major renovations (confirm requirement with Engineering Services). Computer shall have lighting control software pre-loaded. Verify hardware and system requirements with Engineering Services.

6. Refer to Lighting Control Devices in section 20 09 00 and to the BAS Specification for further luminaire control requirements.

H. Lab Panels – limit available short-circuit current to under 10,000 AIC. Discuss current-limiting solution with Engineering Services. Provide main breaker, door with lock, and tamperproof screws.

26 24 19 Motor-Control Centers

.01 General

A. Motor Control Centers

1. Structures shall be totally enclosed, dead front, free standing. Provide guide rails for control units, accessible wireways and terminal blocks for control wiring. Individual buckets must be of the draw-out design capable of safe removal (with door shut and latched) without de-energizing the common bus, to permit compliance with latest edition of NFPA 70E. Provide product similar to Eaton/Cutler-Hammer I.T. FlashGard.

2. Each starter shall have two normally open and two normally closed auxiliary contacts wired to the terminal blocks, hand, off, auto switch, green run light, red off light. All indicating lamps shall be LED.

3. Starters shall be wired so that upon loss of electrical power, they revert back to automatic operation when power is restored.

4. The motor control center shall be sized for a minimum 25 percent spare capacity, minimum 1 bucket space per upright. Size spaces to accommodate, at minimum, one (1) each of the largest starters provided. It shall be complete with buss bar, rails, wireways and other appurtenances so that other than new starters, no additional hardware is required for future expansion.

5. All internal control wiring to terminate at screwed terminal strips, properly identified for connecting field control wiring.

26 25 00 Enclosed Bus Assemblies

.01 General

A. Consider bus duct for shops and facilities with changing power requirements, as approved by Engineering Services.

26 26 00 Power Distribution Units

.01 General

A. Provide units with electrical metering, networked via BACNet or Modbus that can be accessed via a web browser.

26 27 00 Low-Voltage Distribution Equipment

26 27 13 Electricity Metering

.01 General

A. Provide provisions for digital meter within isolated compartment integral to the service entrance equipment. Compartment shall include CT’s on a shorting block and voltage connection brought to a fuse block with disconnect (mount CT’s and voltage connection ahead of the main). PSU Utilities will install service metering. Compartment shall accept a Square D circuit monitor style meter. Provide data connection from the meter location back to the nearest data closet.

1. Sub-meters - When approved, sub-meter location(s) shall have provisions to match those above and shall be co-located within an isolated compartment integral to the service entrance equipment. Provide communication interconnection back to the service entrance meter. Confirm type of meter provisions required with Engineering Services.

2. Distribution panels, ATS’s (where required by ES), and other equipment that does not have space for an integral meter compartment shall incorporate a stand alone meter cabinet, Hoffman #A1412CHFL (14”x12”x6”) or similar. Provide provisions for PSU meter per paragraph A.

26 27 26 Wiring Devices

.01 General

A. Receptacles

1. Receptacles shall be rated 20A, specification grade. Install with ground pin up or left.

2. All requirements for special receptacles shall be discussed with Engineering Services.

3. Receptacles shall be provided at least every 50 feet, in all corridor areas, for operation of floor care equipment.

4. Class 1 Critical Research – provide dedicated twist-lock receptacle on "Standby" (NEC 702 optional standby systems) system power. Provide equipment with a twist-lock cord and cap assembly including an engraved brass tag (consult with Engineering Services for labeling). Engrave outlet cover to read "Class 1 Emergency Power" and the panel/circuit feeding the load. Any load with this designation must be reviewed and approved by Engineering Services.

5. Lab receptacles – utilize stainless steel cover plate and engrave with panel and circuit number feeding outlet.

6. Flat screen TV - Use a 2-gang recessed combination receptacle and CATV outlet similar to the Arlington Industries indoor "in-box", Leviton "recessed entertainment box", or approved equal.

7. Refer to 26 05 53 Identification for Electrical Systems for further labeling requirements.

B. Switches

1. Local wall switches shall be heavy duty, specification grade, quiet operating rocker or toggle type, 20A, 120/277V.

2. Require labeling of switch cover plate for three (3) or more devices ganged together.

C. Device Color Coding:

1. Wiring Device Connected to Emergency Power System: Red (with standard color cover plate).
2. SPD Receptacle: Blue.
3. Isolated-Ground Receptacle: Orange
4. Other Type: as approved.

26 28 00 Low-Voltage Circuit Protective Devices

26 28 16 Enclosed Switches and Circuit Breakers

Provide equipment by the same manufacturer as the service entrance equipment.

26 29 00 Low-Voltage Controllers

26 29 23 Variable-Frequency Motor Controllers

Refer to PSU Variable-Frequency Drive specification.

26 30 00 FACILITY ELECTRICAL POWER GENERATING AND STORING EQUIPMENT

.01 Essential (Emergency and Standby) Power Systems

A. Emergency power source at the University Park Campus should typically be the campus "emergency" and, when required, the campus "standby" cable systems (4160Y/2400V). Coordinate availability with Engineering Services.

B. Where the emergency cable system is not available an engine driven generator shall be provided. Emergency system distribution voltage should be 480Y/277V or 208Y/120V for three phase installations (greater than 50 KVA) and 240/120V for single phase installations (less than 50 KVA). For further requirements, refer to 26 32 13 Engine Generators.

C. Wiring from each branch of the essential power systems shall be kept separate from each other and the normal power system.

.02 Life Safety Power

A. The Life Safety (NEC 700, code required emergency systems) power source at the University Park Campus shall be the campus "emergency" cable system (4160Y/2400V) wherever possible. Coordinate availability with Engineering Services.

B. When provided by the University "emergency" cable, installation shall include:

1. Primary fused disconnect switch with current limiting fuses and lighting arrester
2. Dry type, high-efficiency transformer
3. Secondary overcurrent protection
4. Transfer switch
5. Provide provisions for power meter (meter provided by PSU). Provisions shall match those as noted in Electricity Metering section.

C. Life Safety service Loads shall include, but not be limited to:

1. Egress lighting
2. Exit signage
3. Fire alarm system
4. Sprinkler equipment
5. Smoke detection system
6. Telephone equipment
7. Building Automation System infrastructure equipment

.03 Critical Power

A. Installation only to occur when approved by Engineering Services. The Critical Branch (NEC 701, legally required standby systems) power source at the University Park Campus shall utilize the campus “standby” cable system (4160Y/2400V), wherever possible. Coordinate availability with Engineering Services.

B. When provided from the “standby” cable, installation shall include same components as the Life Safety Power system.

C. Critical service Loads shall include, but not be limited to:

   1. Elevator, but only when required by AHJ
   2. Animal rooms
   3. Other loads as required by AHJ

.04 Standby Power

A. The Standby Branch (NEC 702, non-required standby systems) power source at the University Park Campus shall utilize the campus “standby” cable system (4160Y/2400V) wherever possible. Coordinate availability with Engineering Services.

B. When provided from the “standby” cable, installation shall include same components as the Life Safety Power system.

C. Standby service loads shall include, but not be limited to:

   1. Class 1 (irreplaceable) research loads shall be determined by each College. Utilize dedicated breaker and single twist-lock receptacle per “Devices” section. Coordinate these loads with the Engineering Services so that they can be numbered and tracked.

26 32 00 Packaged Generator Assemblies

26 32 13 Engine Generators

.01 General

A. When use of a generator is approved by Engineering Services, coordinate manufacturer, silencer type, fuel type, amount of fuel storage, and other options.

B. Maintenance: Not more than four hours' normal travel time from Installer's place of business to University.

C. Equipment shall not be installed on building roof or other locations that are difficult for service and replacement.

D. Consider paralleling equipment to allow for testing under load and demand side reduction.

E. Specify a 5 year full coverage warranty.

F. Coordinate monitoring requirements with the BAS Specification.

G. Emissions for internal combustion engines rated at greater than 100 brake horsepower – The University Park campus has a Title V Air Quality Permit, which sets limits on the total annual emissions, and requires documentation and testing of all fuel-burning equipment. The PA DEP is likely to use New Source Performance Standards and National Emissions Standards for Hazardous Air Pollutant to establish emissions limits for the applicable pollutants, testing requirements, data collection and reporting, and other requirements.

Design professional must review the applicable regulations and provide emissions data for the identified pollutants that are the lowest achieved by the proposed engine type in practice, and that can be guaranteed when installed at University Park. Because these limits will have to be supported by data collection, specify equipment to collect, record, and report such data. Discuss provisions and costs of installing CEMS (Continuous Emissions Monitor System) and CPMS (Continuous Parametric Monitoring System) equipment with Engineering Services.

Specify that each engine manufacturer provide emissions data for the identified pollutants that are the lowest achieved by the proposed engine type in practice, and that can be guaranteed when installed at University Park. One manufacturer should be the base bid, and the “equals” as bid alternates so that the material costs can be compared versus each engine pollutants during the bid process. Non-responsive bidders may be eliminated from consideration. Note that the successful bidder will be judged only partially on the cost, the emissions data will also weigh heavily in the final equipment selection.

26 35 00 Power Filters and Conditioners

26 35 33 Power Factor Correction Equipment

.01 General

A. Building power factor shall be, at minimum, 0.95 lagging. Provide central dynamic PF correction at each normal power service entrance as a deduct alternate (estimate the amount of capacitance required and dedicate floor space in the main electrical room).

B. For main-tie-main systems, provide separate dynamic PF correction at each end, each not less than 0.95 lagging when feeding each side of the gear separately. Specify a second set of CT's, one (1) on each side of the tie breaker, connected in parallel with the CT on it's side of the main. Each "tie" CT must be wired in reverse polarity to the main so that the system works properly with the tie closed.

C. Final capacitor selection shall occur within 6 months after building occupancy and shall be based upon actual field measurements at that time.

D. Coordinate sizing with Engineering Services.

26 36 00 Transfer Switches

.01 General

A. Transfer switch shall contain SPDT contacts for central control system, and a sufficient number of poles to switch phase wires plus a neutral wire where necessary. Transfer switch shall include capabilities for monitoring "normal source acceptable", "emergency source acceptable" and "switch status". Monitoring points shall be connected to the building automation system. Transfer switch shall include provisions to accept two remote inputs; "transfer/exercise" and "engine exercise". Refer to BAS Specification for complete requirements.

B. Transfer switch shall be similar to ASCO 4000 series or ASCO 7000 series if bypass isolation is required. Typically, provide solid neutral connection and open transition without delay. Discuss the following options with Engineering Services:

1. Overlapping neutrals on systems with ground fault protection
2. Closed transition (for generator systems only)
3. Paralleling
4. Delayed transition
5. Bypass Isolation (for buildings requiring maintenance without interruption)

26 40 00 ELECTRICAL AND CATHODIC PROTECTION

26 41 00 Facility Lightning Protection

.01 General

A. Consult with Engineering Services to determine if a lightning protection system is required.

B. System components shall be copper.

C. System installation shall be concealed within the building structure.

D. Design per NFPA 780 and require a U.L. Master Label.

26 43 00 Surge Protective Devices

26 43 13 Surge Protective Devices for Low-Voltage Electrical Power Circuits

.01 General

A. Service Entrance – Provide SPD at each building service. Unit should typically be 240 kA per phase, 120 kA per mode (including all phases and phase to ground), but confirm actual rating with Engineering Services. Unit to have disconnect and field replaceable MOV's. Integral mounting within the service entrance equipment is preferable, but surface mounting is acceptable as approved by Engineering Services (keep the leads to the bus 60 inches or less). Unit shall comply with most recent edition of UL 1449 and UL 1283.

26 50 00 LIGHTING

26 51 00 Interior Lighting

.01 Lighting Design

A. Minimize the use of different lamp styles and wattages. Maximize the use of the 48 inch T8 lamp as this source has the best combination of efficiency (about 100 lumens/watt), life (approaching 40,000 hours for major manufacturers), and low cost. The use of this lamp will save energy, reduce material sent to recycling/landfills, decrease maintenance costs, and save money on lamp replacements.

B. The professional shall submit two (2) copies of computer generated point-by-point calculations of most interior spaces to Engineering Services for review. The use of certain “typical” rooms shall be acceptable except when the amount of fenestration or the room orientation changes. Show calculations for each space without daylight contribution as well as with daylight contribution and lighting controls. Point levels shall be legible shown on a scale drawing. All pertinent calculation parameters shall be indicated and highlighted where non-IES compliant. Engineering Services will provide direction and variance where deemed adequate. Utilize AGI-32 full calculation mode or similar program, as approved by Engineering Services.

C. The Illuminating Engineers Society Lighting Handbook, current edition, shall be used as a standard for lighting levels. For television studios and classrooms used for TV production, consult Engineering Services for guidelines.

D. Discuss the use of LED technology with Engineering Services where applications exist.

E. Medium and high bays in shops, lobbies, etc. should take into account lamp life, lamp replacement, and controllability. Investigate the use of T8 fluorescent lamps (with high ballast factor ballast) versus T5HO in these applications, and discuss options with Engineering Services. Ballasts must be rated for high temperature environment.

F. Provide two (2) copies of a light fixture cutsheet booklet with any submittal showing lighting layouts. Booklet shall be in color and include the light fixture schedule as well as proposed lighting controls.

G. Specify the proper disposal of high mercury content lamps per PSU Policy SY-31 and PCB ballasts per PSU Policy SY-26 for all renovation work.

.02 Lamps

A. Linear fluorescent lamps shall be the T-8, 32-watt, rapid-start, 3100+ initial catalog lumens, 24,000+ hour with instant start ballasts at industry standard 3 hour cycles. The use of other fluorescent lamps is discouraged. The use of linear T-5 fluorescent lamps is allowed where design applications exist, and it is approved by Engineering Services. Compact fluorescent lamps should be triple-tube style, 32W for downlights and 18W for wall sconces. Coordinate other lamp wattages and styles with Engineering Services. All fluorescent lamps will typically incorporate a 3500 degree Kelvin temperature and a minimum CRI of 80-86. Qualifying T8, 48 inch linear lamps are as follows:

1.	GE High Lumen:	F32T8/XL/SPX35/HL/ECO
2.	Philips Advantage:	F32T8/ADV835/ALTO
3.	Sylvania XPS:	F032/835/XPS/ECO

B. The use of incandescent lamps is discouraged and shall be only as approved by Engineering Services.

1. “A” lamps shall be long-life, rated 125 volts, with inside frost.
2. MR-16 lamps, up to 50 watt, shall be 10,000 hour.

C. Require that the contractor obtain all similar lamp types through one source from a single manufacturer.

D. Lamp Orientation: All lamps shall be specifically rated for the burn position in which they are used. Universal burn lamps are only acceptable in luminaires that will require aiming that will result in a lamp orientation that is neither vertical nor horizontal.

E. Fluorescent dimming: All fluorescent lamps on dimming ballasts shall be burned in at full brightness for 100 hours (or as required by the lamp manufacturer) continuously prior to any dimming. Bypass local control as necessary to accomplish this task.

.03 Ballasts

A. Fluorescent ballasts shall be “premium” efficiency, electronic, CBM and ETL approved with a sound rating of A. Ballast shall also be Class P, thermal cut-out switch, rated where required by U.L. Investigate use of high or low ballast factor as part of the illumination calculations. Linear ballasts shall be as follows:

1. PRS (programmed rapid start ballast) – use with occupancy sensors or in frequent switching applications.

    a. Advance “Optanium”
    b. GE “UltraStart”
    c. Sylvania “PROStart”
    d. Universal “AccuStart8”

2. IS (instant start ballast) – use with manual switched lighting and unswitched emergency luminaires.

    a. Advance “Optanium”
    b. GE “UltraMax”
    c. Sylvania “QHE”
    d. Universal “ULTim8”

B. Provide label sticker on each luminaire ballast chamber (in 1/8” lettering) to read either “___V; Instant-Start; _.__ Ballast Factor” or “___V; Program-Start; _.__ Ballast Factor” (insert the voltage and ballast factor in each underlined space). As an example, label might read “120V; Program Start; 0.88 Ballast Factor.”

C. Specify an in-line disconnect to meet 2008 NEC 410.130(G). Further require that the lighting manufacturer provide a “wire nut” connection on the load side of the disconnect to facilitate ballast replacement. Refer to picture below:

.04 <u>Luminaires</u>

A. Lens shall be 100% virgin acrylic injection molded prismatic diffusers meeting the ASTM specifications for methacrylite molding compounds D.788-69A. Minimum lens thickness shall be 0.125”.

B. In mechanical rooms, storage rooms, and other unfinished areas consider lensed fluorescent strip lighting.

C. Classrooms – Utilize high quality pendant mount indirect/direct lighting (with fully separate indirect and direct components) for classrooms, as long as luminaires don't interfere with sight-lines and ceiling-mount projection equipment. Refer to the classroom committee recommendations for additional information.

D. Use high quality pendant mount indirect/direct lighting for offices, laboratories. Provide levels of switching in accordance with IECC requirements.

E. Where HID luminaires are used indoors, they shall be of the low sound level with encapsulated ballasts, or electronic ballasts when available for specified wattages.

F. Metal Halide Lamps and ballasts shall be pulse start, where available for specified wattages, and rated for "open" fixtures.

.05 Installation

A. Recessed compact fluorescent and 2x2 fluorescent luminaires shall be installed such that lamps are aligned in the same relative orientation from one fixture to the next.

B. Cleaning: All luminaires shall be thoroughly cleaned and clear from dust, paint, construction debris and fingerprints after all other trades are complete, but prior to the date of substantial completion.

26 52 00 Emergency Lighting

.01 General

A. Each building shall be equipped with an egress lighting system as required by the Pennsylvania Department of Labor and Industry or other applicable code(s).

B. Provide emergency lighting along the path of egress, including the exterior of a building and ending at a public way (or as approved by Engineering Services).

C. All egress lighting (which includes stairwell lights, exit lights, selected corridor lights), fire extinguisher identification lights, and elevator cab lights shall operate twenty-four (24) hours a day and shall be connected to the Life Safety panel. There may be some deviation from this depending on the type emergency lighting installed and the amount of daylight available in any given space.

D. Battery type emergency lighting should be avoided.

E. Stairwells, lobbies, hallways and entrances shall have ample lighting to allow for night cleaning. Wall mounted ADA compliant fixtures with integral occupancy sensors and dimming ballasts are preferred for stairwells because they reduce energy usage and eliminate the need of high ladders and scaffolds for re-lamping. Utilize the Lamar Lighting “VO” series, Lumax “COD”, or equal luminaire.

F. Do not use of lamps with end-of-life protection (compact fluorescent and T5) in Normal/emergency lighting applications. Ballasts for these lamps have “end of life” circuitry that can turn off lamps in certain power fluctuation conditions and leave the building without egress lighting until fixtures are de-energized and re-energized. Specify these ballasts to have automatic re-strike capability.

26 53 00 Exit Signs

.01 General

A. Exit lights shall be red LED and have stencil face with red letters. Flush mount types are desirable because they are more vandal-proof. Consider vandal-resistant models for dormitory design.

B. Self-contained exit signs powered by a radioactive source (tritium or similar) are not acceptable.

26 56 00 Exterior Lighting

.01 General

A. Roadway and Open Parking Area Lighting

1. Light Source: Light sources for roadway and open parking area lighting shall be of the high intensity discharge, single arc tube, high pressure sodium or metal halide type.

2. Luminaire: Luminaire shall utilize a cut-off optical assembly, a 250 watt high pressure sodium lamp and an IES distribution as required to maintain recommended lighting and uniformity levels. Luminaires shall be rectangular in shape and conform to a “shoebox” design. Integral ballast shall be auto-transformer, regulated type, voltage as directed by Engineering Services. Luminaires shall be Lumark Hammer series, finished dark bronze with a 10 inch arm for connection to square pole. Any exception to this luminaire must be approved by

Engineering Services Architect prior to the final design submission.

3. Pole: Poles shall be 25 ft, 5” square, non-tapered fiberglass with handhole at base, finished dark bronze. Professional shall coordinate final height of poles with local ordinance stipulations and other University requirements. Suggested manufacturer for pole is Shakespeare, Series AR. Use of poles lower than 25 ft is discouraged and must be approved by Engineering Services.

4. Concrete Base: Concrete bases shall utilize rebar reinforcement and embedded anchor bolts, and shall be designed to support the pole and luminaire assembly utilizing local wind load parameters and assembly effective projected area (EPA). Bases shall protrude above grade 6” with a top beveled edge. Bases shall protrude 36” above grade where damage from vehicles is possible. Above grade concrete shall be finished smooth.

5. Contact Engineering Services for typical CADD details.

6. Illumination Levels:

   a. Roadway and open parking area illumination levels shall comply with the following. Areas not covered herein shall comply with the latest IES recommendations. Roadway illumination levels outside of core campus shall be reviewed with Engineering Services. Lower average levels may be acceptable.

ROADWAYS		
	Avg Maintained FC (Min)	Avg/Min Ratio
Roadway Illumination @ Grade	1.50	3 : 1

BUS PULL-OFF AREAS		
	Avg Maintained FC (Min)	Avg/Min Ratio
* Bus Pull-Off Area Illumination @ Grade	2.50	3 : 1

* Bus pull-off area shall include the area of roadway traversing the length of the bus pull-off and all roadway pedestrian crosswalks within the area of the pull-off.

EXTERIOR OPEN PARKING FACILITIES				
	General Parking & Pedestrian Areas		Vehicle Use Only	
Activity Level	Min FC @ Grade	Avg/Min Ratio	Avg FC @ Grade	Avg/Min Ratio
* High	0.9	4 : 1	2.0	3 : 1
Medium	0.6	4 : 1	1.0	3 : 1

* Beaver Stadium and Jordan Center are considered areas of high activity levels.

7. Calculations – The professional shall submit two (2) copies of computer generated point-by-point calculations to Engineering Services for review. Point levels shall be legible and plan to scale. All pertinent calculation parameters shall be indicated and highlighted where non-compliant. Engineering Services will provide direction and variance where deemed adequate.

8. Sub-metering of Parking Lots – Provide provisions for Square D power meter (actual meter by PSU) for all parking lots. Provisions shall match those as noted in "Electricity Metering" section. Confirm requirements with Engineering Services.

B. Walkway Lighting:

1. Light Source: Light sources for walkway lighting shall be of the high intensity discharge, metal halide type clear lamp, pulse-start. Source shall provide a minimum color rendition index (CRI) of 92 and a Kelvin temperature of 4000. Where sidewalks are adjacent to roadways, the roadway light source shall be deemed acceptable where the minimum lighting levels are satisfied. Otherwise, the professional shall review alternatives with Engineering Services.

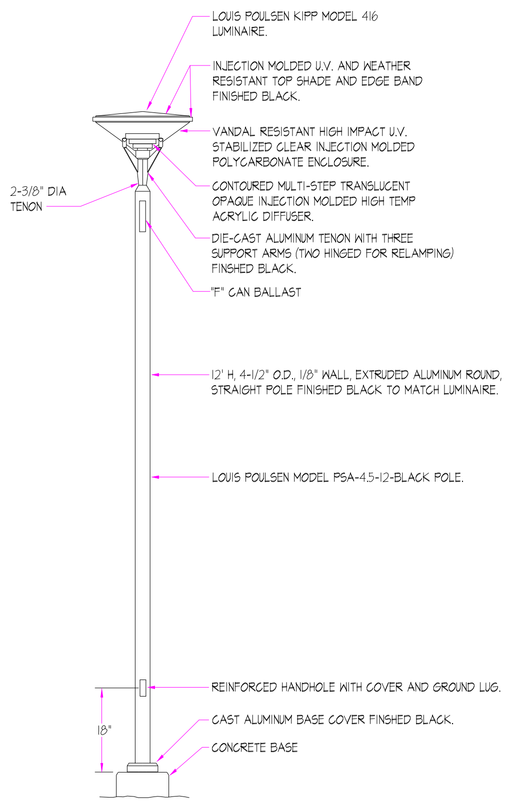
2. Luminaire: Luminaire shall be conical shaped, low profile, incorporating a pressure die-cast UV and weather resistant black top shade, vandal resistant high impact UV stabilized clear injection molded polycarbonate enclosure and a three-arm support. Lamp shall be concealed by use of a contoured, graduated reflector shade creating a symmetrical round type V distribution. Luminaire shall include 100 watt metal halide lamp and integral "F" can ballast available in either 120V or 277V. Luminaire shall be Louis Poulsen KIPP, model 416. Any exception to this luminaire must be approved by the University Architect prior to the final design submission.

3. Pole: Pole shall be 4.5 inch diameter, round,

straight aluminum pole with handhole at base, split cast aluminum base cover and shoe base. Pole shall be 12 ft in height and finished black. Pole shall be Louis Poulsen model RSA-4.5-12-Black.

4. Concrete Base: Concrete bases shall utilize rebar reinforcement and embedded anchor bolts and shall be designed to support the pole and luminaire assembly utilizing local wind load parameters and assembly effective projected area (EPA). Bases shall protrude above grade 6” with a top beveled edge. Above grade concrete shall be finished smooth.

5. Contact Engineering Services for typical CADD details.



STANDARD WALKWAY LUMINAIRE AND POLE DETAIL

6. Illumination Levels:

   a. Walkway area illumination levels shall comply with the following. Areas not covered herein shall comply with the latest IES recommendations. Walkway calculation areas (distant from roadways) shall include a 6 ft area bordering the walk on each side, illuminated to a level of one-third the levels suggested for walkways for additional pedestrian safety. Walkways leading to a building entrance shall be designed for the specified walkway illumination levels, and not the levels set forth by IES Building Entrance requirements.

Walkway Classification	Avg Maintained FC @ Grade (Min)	Avg Vertical FC @ 6Ft Above Grade	Avg/Min Ratio
Roadside Walkways	1.0	1.5	4 : 1
Walkways Distant from Roadways	0.5	0.5	4 : 1

7. Calculations:

   a. The professional shall submit two (2) copies of computer generated point-by-point calculations to Engineering Services for review. Point levels shall be legible and plan to scale. All pertinent calculation parameters shall be indicated and highlighted where non-compliant. Engineering Services will provide direction and variance where deemed adequate.

   b. Coordinate the method of calculating the vertical footcandle requirement for Walkways with Engineering Services.

8. Façade Lighting – Do not light the building façade unless otherwise approved by Engineering Services.

.02 <u>“Site” (Walkway, Roadway, and Parking) Lighting Circuitry</u>

A. All underground circuitry shall be installed in 1-1/4” PVC schedule 40 conduit with burial depths in accordance with the latest edition of the NEC, or as directed by Engineering Services.

B. Where multiple phases of power are utilized for circuit, luminaires shall be connected to alternate phases (to neutral) throughout run.

C. A direct buried handhole shall be installed adjacent to the base of each concrete pole base. Handholes installed within grass areas shall be similar to Penncell model PE-9. Handholes installed in concrete shall be similar to Quazite model PG, minimum 12” x 12” square OR 9” diameter round, with open bases. Provide heavy-duty covers where subject to vehicular activity.

D. Provide in-line waterproof fuseholders with appropriate fuse for each luminaire, installed in handhole serving the pole. Fuse holders shall be similar to Bussman HE Style.

E. Provide 5/8” x 8’ copper clad ground rod for each pole, installed inside direct buried handhole. Rod shall be connected / bonded to equipment ground and pole grounding lug, where applicable.

F. All wiring connections made at or below grade shall be waterproof with UL listed waterproof connectors.

G. Run separate circuit(s) to each type of lighting (roadway, parking, and walkway). Refer to “Lighting Control Devices” in Section 26 09 00.

H. Contact Engineering Services for typical CADD details.

DIVISION 27 – COMMUNICATIONS

27 00 00 COMMUNICATIONS

27 05 00 Common Work Results for Communications

.01 General

A. Refer to the PSU TNS (Office of Telecommunications and Network Services) Minimum Standards for Telecommunications Facilities for requirements.

B. Room Grounding Requirements

1. Provide a wall mount bare copper ground bus in each communication equipment room (on insulated supports). Bus to be minimum 1/4 inch by 2 inch by 24 inches long, mounted on insulators. Run bare copper ground to main ground bus near electrical service entrance equipment. Run minimum 4/0 copper conductor to the service entrance ground bus.

27 05 43 Underground Ducts and Raceways for Communications Systems

.01 Underground Conduit

A. Communication conduit shall be 5-inch PVC. Type EB is acceptable. Elbows shall be long-sweep rigid steel to prevent abrasion during cable installation.

B. All conduits shall be concrete-encased. Require steel reinforcing under traffic areas. Specify a minimum of 24" conduit cover in non-traffic areas, and 30" cover under traffic areas. Install a traceable marking tape above the concrete envelope.

C. Run a minimum of six conduits between manholes; run at least four conduits from the manhole to a major building.

D. Test all conduits after installation to verify that none are blocked or crushed. Upon completion of testing, install a minimum 300#-test, non-degradable pull line in each conduit.

E. Coordinate conduit location and quantity with Engineering Services and TNS.

F. Contact Engineering Services for typical CADD details.

.02 Manholes

A. Telecommunication manholes shall be precast or poured in place with pulling irons and cable supports. Minimum size shall be 8' x 8' x 7' inside clear, coordinate exact size with Engineering Services

B. Manholes shall be fitted with nonlocking-type frame and cover suitable for highway use. Cover shall meet applicable PennDOT standards and have the word "TELEPHONE" cast in 3" letters. Opening shall be 30" clear.

C. Factory end bells shall be used where conduits penetrate manhole walls.

D. Grounding – All electrical systems shall be suitably grounded, including all non-current carrying metallic components of all equipment and metallic conducts. Grounding shall be accomplished as required by the National Electrical Code.

E. Contact Engineering Services for typical CADD details.

DIVISION 28 – ELECTRONIC SAFETY AND SECURITY

28 00 00 ELECTRONIC SAFETY AND SECURITY

28 30 00 ELECTRONIC DETECTION AND ALARM

28 31 00 Fire Detection and Alarm

.01 Microprocessor-Based Fire Alarm Systems (Standard for most buildings)

A. The automatic fire detection and alarm system shall consist of a microprocessor-based main control panel, Siemens MXL with CMI300 modem (specify that TNS make connection to the central monitoring facility at Eisenhower parking deck), printer, remote annunciator(s), detection devices, manual stations, and alarm-indicating appliances wired in accordance with the schedule on the drawings. System shall function as specified in Factory Installation Manuals.

B. University Park systems shall be compatible with, and able to report to and be controlled by, the Siemens Pyrotronics CXL Fire Command Center used by University Police Services. Other campus fire alarm systems shall be as approved by Engineering Services.

C. System shall typically be “Class B” with the following styles:

1. Initiating style B
2. Signaling (addressable loops) style 4.
3. AC: Style Y.

D. Each detector location shall be capable of being annunciated at the control panel.

1. The system shall be capable of multiple alarm reporting.

2. The system shall be capable of initiating and indicating an alarm condition in a degrade mode of operation in the event of processor failure.

3. The system shall be capable of performing a one-person walk test of either the complete system or each individual zone, thereby maintaining full functionality of all zones not being tested.

4. Provide 20% spare capacity per notification appliance circuit and per initiating device

circuit. The head-end of the system shall be capable of being expanded at any time up to the predetermined maximum capacity of the system.

5. The system shall be capable of being programmed in the field for the purpose of future expansion.

6. The system shall be capable of going into the Alarm Mode from other modes of operation, such as Test Mode, Trouble Mode, etc.

7. The system shall be capable of measuring the sensitivity of the various detectors connected to it. There should also be a hard copy printout of the sensitivities.

8. External circuit supervision shall not require additional wires other than the pair used for detection or alarm (only two wires shall be used from the control panel to each loop initiating devices and two wires for audible devices). These two wires shall provide both supervision and alarm signals.

9. There shall be no limit, other than maximum system capacity, as to the number of intelligent/analog devices which may be in alarm simultaneously.

10. The system shall function as follows when an area or duct detector, manual station, water flow switch, or other initiating device operates:

    a. Utilize alarm verification functionality for all smoke detectors, with the exception of those associated with elevator recall, prior to sounding general alarm.

    b. Sound required audible.

    c. Automatically notify University Park Police Services.

    d. Display an individual detector and/or zone number on alphanumeric display with user-defined message.

    e. Light an indicating lamp on the area or duct detectors initiating an alarm.

    f. Shut down the HVAC system and operate dampers in the alarmed smoke zone.

    g. Initiate the elevator recall sequence.

    h. Close all magnetically held fire doors.

11. Provide full detection for dormitory buildings. Resident room detectors shall have audible bases. Utilize the following sequence of operations for each resident room/suite:

    a. Activation of a resident room/suite smoke detector shall immediately initiate all the notification devices in that room/suite only, and shall cause an alarm condition at the fire alarm control panel, all remote annunciators, and at the central monitoring point. If the alarm is not acknowledged within 15 seconds and verified within 180 seconds, the system shall go into general alarm.

    b. Activation of a second detector within the same room/suite, or elsewhere in the building, shall send the system into general alarm.

12. Provide partial detection for buildings, other than dormitories, that have full sprinkler coverage. Confirm specific areas to be detected with Engineering Services, but include the following:

    a. Corridors.

    b. Mechanical and electrical rooms. Mechanical rooms may require heat detection rather than smoke, due to the cleanliness of the environment.

    c. Telecommunications rooms.

    d. Storage rooms

    e. Kitchens

    f. Janitor Closets

13. Additional surge suppression shall be included at 120V AC input to fire alarm power supply and for any conductive wires that run outside of the building footprint.

14. Annunciator panel shall be flush mounted at the entrance closest to the fire department connection and at the main lobby (if these entrances are not the same location).

15. An actual fire alarm system riser diagram including device address and coded message shall be provided with the design documents. A sequence of operation shall be provided with the design documents.

16. All components must be "ADA"-approved.

17. Utilize lead-acid battery backup in lieu of NiCad.

18. All audible alarm devices with temporal sound patterns shall be synchronized.

19. Audible and visual devices to be white in color, except on dark wall surfaces where they should be red.

20. Pull-stations should typically be single-action.

21. Trouble conditions shall be latching.

22. Attempt to get a waiver from sprinklering the elevator machine room(s) and shaft(s) to avoid the requirement for detection and shunt-tripping. If this cannot be avoided, utilize 2 heat detectors one 135 F rate-compensated to recall the car and one fixed at 200 F (or similar) to initiate the shunt trip just prior to the sprinkler operation. Locate 200 F heat detector within 1'-0" of the sprinkler head.

23. Detectors shall not be installed until all work of all other trades is complete, per NFPA 72.

24. Remote Power Supplies and/or Booster Panels: Panels shall not be located in finished spaces. Provide a smoke detector at each panel location.

25. Specify that any duct detector message shall denote the building area covered by that air handler, not the location of the duct smoke detector in alarm.

26. Provide FACP with a sprinkler flow test function so that system does not go into general alarm. Flow alarm disablement shall last 120 minutes and then return to normal condition.

27. Provide FACP with elevator test function so that system does not go into general alarm. Elevator test disablement shall last 120 minutes and then return to normal condition.

28. Provide electronic and hard copy of fire alarm floor plan(s) as-built drawings showing each device with loop identification number and/or address. Plans shall show no other equipment other than fire alarm system.

29. All wiring shall be run in conduit.

30. Mount fire alarm pull stations and similar devices at 44” AFF.

31. Mount fire alarm horns, strobes, horn/strobes, etc. at 90” AFF (to top of lens) or 6” below finished ceiling, whichever is lower.

.02 Conventional Fire Alarm Systems
(only when approved by Engineering Services)

A. Fire alarm system shall be single supervised, non-coded continuous ringing.

B. Stations shall not have a glass rod or glass plate which must be broken.

C. It shall be possible to start and stop a fire alarm test from any station without the need of resetting at the control panel.

D. Specifications shall include a statement that prohibits the use of a thermal cutout in the bell circuit.

E. Fire alarm system shall be connected to the normal/emergency service. Battery backup shall be provided in the control panel.

F. Fire alarm bells in finished areas shall be factory prime coated only. Field painting color shall be selected by Professional.

G. Control panel shall contain a SPDT contact for the Central Control System.

H. Alarm components for sprinkler systems shall be approved by Factory Mutual.

I. Panels shall be of modular design for ease of expansion.

J. Panels shall contain built-in voltage surge suppressors.

K. Install a separate grounding conductor in all conduits.

L. Smoke detection systems, if required, shall be the ionization type. The control panel for this system shall be connected to the normal-emergency service. The control panel shall also activate the fire alarm system. Smoke detection systems not connected to a fire alarm panel shall have battery backup.

M. The annunciator panel shall be installed in an area that will permit visual indication of the detector which has been activated to be easily identified.

N. Fire Alarm/Smoke Detection System shall be Pyrotronics.

O. An actual fire alarm system riser diagram including device address and coded message shall be provided with the design documents. A sequence of operation shall be provided with the design documents.

P. All components must be "ADA"-approved.

Q. Manual and automatic fire alarm systems shall be designed with a minimum of one zone per floor. Manual and automatic devices may be connected to the same zone. Additional zones shall be provided for floor areas that exceed 20,000 square feet.

R. A remote annunciator shall be installed when more than one zone is required.

DIVISION 31 – EARTHWORK

31 00 00 EARTHWORK

31 01 00 General Requirements and Owner Intent

.01 Earth Disturbance Management Guidelines

A. Introduction

On March 13, 2003, the Pennsylvania State University commitment to erosion and sedimentation control was elevated to a new level when the University submitted its municipal separate storm sewer system (MS4) permit application. The MS4 permit requires the University to manage storm water using the six best management (BMP) practices of:

1. Public education
2. Public participation
3. Illicit discharge detection and elimination
4. Construction storm water management
5. Post construction storm water management
6. Pollution prevention

The following guidelines address the University's commitment to addressing construction storm water management. This will be addressed in a five level system that outlines the practices that need to be used in all earth disturbance situations. All disturbances less than 5000 ft^2 shall be handled with OPP staff, while those above 5000 ft^2 shall be submitted to the local conservation district for approval.

These guidelines utilize Engineering Services as the contact and manager of the permits and E&S plans. This centralization of the permits will allow the management of all permits' requirements. All renewal and revision tracking will be the responsibility of Engineering Services. All fees and professional services associated with renewing or revising these permits will be the responsibility of the project for which coverage exists.

B. Erosion and Sediment Control Plan Levels

1. Level 1 - Minor Earth Disturbances Less Than 1000 ft^2

   Level 1 disturbances are less than 1000 ft^2 and with slopes less than 5% such as tree planting, garden management, flower bed restoration, minor turf restorations, and flower planting. Aeration and over seeding activities of turf areas of unlimited size are included in this level.

In most cases these activities are of short duration, 1 to 2 days, and provide little or no opportunity for sediment pollution. The control measures associated with this work would consist mostly of installation of mulch at the conclusion of work and clean up of adjacent landscape.

2. Level 2 - Earth Disturbances Less Than 1000 ft^2

Level 2 disturbances are less than 1000 ft2 and will cover earth disturbances that involve the use of heavy construction equipment, durations greater than 2 days, slopes greater than 5%, and in close proximity to storm water features. Examples of these disturbances would be utility work, landscape installation, turf restoration on slopes and or in close proximity to storm inlets and flower beds on slopes greater than 5%.

Erosion and Sediment Control (E&S) for such activities will be at the discretion of the project leader. In most cases, this would include, but not be limited to, mats for access, silt fence, silt socks, inlet bagging, and a filter bag for pumping. Project leaders will require training on E&S controls. Projects managed by leaders not trained will be required to follow Level 3 criteria. In the event of complication, the Manager of Engineering Services or his designee will provide direction as required.

3. Level 3 - Earth Disturbances Greater Than 1000 ft2 and Less Than 5000 ft^2

All earth disturbances greater than 1000 ft2 and less than 5000 ft2 will require an E&S plan. This plan, while not requiring approval by the conservation district, must be protective of the waters of the commonwealth and as such should follow the 25 PA Code 102.

These plans will consist of a map of the area that delineates the disturbance and the best management practices or E&S controls to be utilized during the disturbance. A narrative should describe the area in ft2, the sequence of operations, erosion control installation, maintenance, and removal determinations. Details for E&S control measures are available in the Pennsylvania Department of Environmental Protection Erosion Control Manual. All E&S plans for projects greater than 1000 ft2 and less than 5000 ft2 will be approved by the campus designee and a copy kept on file. All projects in this category at University Park will be entered into a spreadsheet and reported to the local conservation district for monthly review.

4. Level 4 - Earth Disturbances Greater Than 5000 ft^2

   Earth disturbances greater than 5000 ft2 must be covered by an E&S plan. When such a disturbance is within an existing NPDES permit boundary, the E&S plan will serve as a revision to the permit. (See flowchart labeled "PSU Earth Disturbance Process" at end of Division 31.) The E&S plan must be developed and submitted to the local conservation district for approval. The plan shall be developed using 25 PA Code 102 as a reference. All plans for the University shall be submitted to the local conservation district through the Manager of Engineering Services or his designee. Submissions should be comprised of 4 plan sets, an application, and a check made payable to the local conservation district. Upon approval by the conservation district, the plan information will be logged, and approvals will be copied and approvals attached to the file copy for forwarding to the appropriate project manager for distribution to the contractor. All originals will be maintained at Engineering Services. Note: An approved copy must be at the job site at all times.

5. Level 5 - NPDES Permits

   When earth disturbances are greater than one acre with a point source discharge to the waters of the commonwealth or greater than five acres, a NPDES permit is required. If sufficient development will take place on the campus over the next ten years, the total campus area or a manageable section of the total area should be included in the NPDES permit boundary.

   The application process for the General and Individual permit is shown in the referenced flow chart. The professional will submit four sets of E&S plans, NPDES application form (Individual or General), application fee, and the General Information Form to the Manager of Engineering Services for logging, review, and submission.

   Once the permit is reviewed and issued by the Conservation District or DEP, it will be logged, approvals copied and attached to the file copy for forwarding to the appropriate project manager for distribution to the contractor. All originals will be maintained at Engineering Services. Notes: Prior to starting the earth disturbance, a copy of the original permit will be required to be on site. All jobs excavated by outside contractors will require permit coverage through a co-permittee agreement.

C. Erosion and Sediment Control plan notes.

Visual site inspections are to be performed on at least a weekly basis and after each measurable precipitation event to ascertain that the E&S BMP’s are operational and effective. Record all inspections on Penn State’s “Sedimentation Control Inspection Log Sheet” (at the end of Division 31). All preventative and remedial maintenance work, including clean out, repair, replacement, regrading, reseeding, remulching, or renetting, must be performed immediately. The contractor and permittee must attempt, whenever possible, to recycle all waste generated on-site during this project. All waste material not recycled must be disposed of at an approved waste site. For all sites covered by an NPDES Permit, the outside contractor, when applicable, shall develp and implement a Preparedness, Prevention, and Contingency (PPC) Plan.

.02 Test Borings

A. Data on indicated subsurface conditions are not intended as representations or warrants of continuity of such conditions between soil borings. The complete foundation investigation including boring logs and recommendation is available for review from the Professional upon request. It is expressly understood that the University will not be responsible for interpretations or conclusions drawn therefrom by the Contractor. Additional test borings and other exploratory operations may be made by the Contractor at no cost to the University, with the understanding that he is fully responsible for any damage resulting therefrom and he restores the site to its original condition upon completion.

.03 Inspection and Testing

A. Continuous inspection and testing by a testing laboratory with a Soils Engineer as approved by the Professional shall be provided during filling and compaction. All footing excavations shall be inspected by a qualified inspector to ascertain that all excavations have penetrated topsoil, soil with organic matter, or fill to undisturbed soil; that the bottom of the excavation is on suitable bearing material; and that all loose material, water and water-softened material has been removed just prior to placing concrete. The Contractor shall contract and pay for the services of the testing laboratory and the Soils Engineer. Copies of the reports from the testing laboratory shall be forwarded to the Contractor, the University, and the Professional.

B. Compaction Tests (if required)

1. The Contractor shall employ a recognized testing laboratory, approved by the Professional, to perform verification testing of compaction.

2. The Professional and the University reserve the right to direct where tests shall be taken.

3. Certification of compliance from testing laboratory shall be provided to the Professional, which shall state that the earth compaction conforms to the requirements of these specifications. Certificates shall be received and approved by the Professional prior to concreting operations.

.04 Soil Protection Zones

A. General

1. Intent:

a. The Pennsylvania State University is committed to protecting its native soils.

b. The Soil Protection Zones shall be protected during the entire construction process.

c. Areas within the Soil Protection Zone shall not be turned, excavated, compacted, or altered in any way.

2. Protection of Existing Utilities:

a. Prior to any work being performed the Contractor shall insure that all existing utilities within and surrounding the project site have been clearly marked in accordance with the Pennsylvania Underground Utility Line Protection Act, Act 287 as amended by Act 199.

3. Submittals

a. The Contractor shall meet with the University Representative prior to beginning any excavation, grading or other construction activities to review and verify all work procedures, trailer locations, stockpile and staging areas, access and haul roads, equipment operation methods, and soil protection measures.

1) The Contractor shall provide a scaled grading plan indicating all existing and proposed grading. Limits of disturbance will be marked/labeled on the plan to outline all soil protection measures. This plan will become part of the construction documents.

b. The Contractor shall submit a written guarantee that he/she shall not enter the soil protection zones at any time during construction without first getting approval from the University Representative.

c. The Contractor shall verify in writing that all soil protection measures have been met.

4. Soil Protection Zones

a. Prior to the start of any site work the Contractor will erect fencing around existing soil volumes which are to be preserved within the construction site.

b. Soil protection areas outlined on the plan to not be disturbed shall be protected from unnecessary excavation, compacting, and/or spoiling during the entire construction process. Protection of these zones shall be by the placement of temporary fencing as outlined in Part B.1.b - Materials.

1) NO REMOVAL OF OR ENCROACHMENT INTO SOIL PROTECTION ENCLOSURES SHALL BE PERMITTED UNLESS COORDINATED WITH THE UNIVERSITY REPRESENTATIVE.

c. The Contractor shall be responsible for the installation and maintenance of all soil protection fencing. Protective fencing shall remain undisturbed until all construction activities have been completed. The Contractor shall remove fencing upon completion of construction and approval by the University Representative.

1) If protective fencing is damaged, the Contractor shall immediately execute the necessary repairs to re-establish it back to its original configurations outlined on the Soil Protection Zone Plan.

2) At the conclusion of the project, as soil protection fencing is being removed, the Contractor shall continue to identify and enforce soil protection

zones through temporary measures until final acceptance. The use of these temporary protection methods is only acceptable for a period not to exceed 5 business days. A list of appropriate materials and methods for temporary protection are listed in PART B.1 – MATERIALS.

3) The Contractor shall be held liable for any damage to the existing soil within the soil protection zone caused by unauthorized intrusions into the protected areas during the construction period.

d. Erosion control devices shall be installed as per the contract drawings with particular emphasis on preventing silting and/or erosion within the soil protection zone.

B. Materials

1. Equipment and Materials:

a. Equipment

1) As selected by the Contractor, except as otherwise indicated, to complete work in a safe manner and to protect all personnel and bystanders involved.

b. Materials:

1) Protective fencing shall be 6 feet high chain link fence supported by 2 inch diameter galvanized iron posts set to a minimum depth of 2 feet. Posts shall be spaced a minimum of 10 feet on center. Movable fence panels may only be used upon approval from the University Representative.

2) An 8 ½” x 11” sign indicating the area as a soil protection zone shall be prominently displayed on each fence panel. Signs may be obtained by contacting the University Representative.

3) Temporary protection measures may be used at the conclusion of the project, up until final acceptance. These methods may include, but are not limited to the use of signs, post and wire, or other methods approved by the University Representative.

C. Execution

1. Scope of work within the Soil Protection Zone:

a. For those construction projects requiring temporary access or haul roads through the protection zone, a roadbed shall be installed using road plates, Alturnamat, or a PADOT Class IV Geotextile base covered with 6 inches (minimum) of mulch, wood chips or gravel to protect soil and minimize soil compaction. Approval shall be given by the University Representative. The roadbed material shall be maintained as necessary to keep its original condition.

b. No material shall be stored or piled within the soil protection zone unless otherwise approved by the University Representative. No gasoline, fuel oil, harmful chemicals or other deleterious materials shall be stored, spilled or deposited on the ground within the soil root protection zone.

c. There shall be no vehicular traffic or parking permitted within the soil protection zone.

d. Foot traffic shall be kept to a minimum within the soil protection zone. If temporary foot traffic must be directed over the soil protection zone a pathway shall be installed using Alturnamat or a PADOT Class IV Geotextile base covered with 3 inches (minimum) of mulch, wood chips or gravel to protect soil and minimize soil compaction. Approval shall be given by the University Representative. The pathway material shall be maintained as necessary to maintain its original state.

e. No access to the soil protection zone is allowed during periods when the soil is excessively wet due to rain or snow unless approved construction access way is in place.

D. Liability:

1. The Contractor shall be held liable for any damage to protected soil volumes. A dollar value shall be determined by an independent soils testing laboratory based on the square footage of compacted soil.

2. The Contractor shall be held liable for any remedial measures required to treat compacted, excavated, or tilled soil within the soil

protection zone. All remedial treatments shall be conducted by the University and/or their designee.

31 10 00 SITE CLEARING

.01 Site Clearance

A. Protection: The Contractor shall provide and maintain adequate guards, fences, lights, warning signs and similar items as may be required.

B. Grubbing: The Contractor shall remove and dispose of all shrubs, stumps and roots larger than 1 1/2" in diameter, to a depth of 20 inches.

C. Plantings to be removed by the University will be removed prior to commencement of any work at the site.

D. Plantings to be removed by the Contractor shall be classified as debris and shall be removed by the Contractor off University property.

E. Disposal of Material: All refuse and other debris shall be disposed of by hauling from the site and off University property.

F. Material to be removed shall be removed daily and shall not be allowed to accumulate on the site.

31 20 00 EARTH MOVING

.01 Excavation--Backfill

A. Proper placement of all erosion-control facilities shall occur prior to any earthwork activity.

B. Puddling will not be permitted.

   1. All backfill must be mechanically tamped, in layers not to exceed 6 inches in depth, and thoroughly compacted to prevent settlement.

C. If blasting is required, refer to standard blasting requirement, Section F.

D. Unclassified Excavation:

All excavation for projects funded by the University will be unclassified and will include (without limitation thereto) the excavation and removal of all soil, shale, rock or rock formations, boulders, existing foundations, fill, and any type of subsurface condition encountered in the contract area.

No claims for extra compensation or extension of contract time because of the nature of subsurface conditions encountered will be considered by the University.

E. General: All excavation shall be to the lines and grades as shown:

1. Six inches below finished grades in seeded areas.

2. To grades indicated at paved areas minus thickness of base course and surface materials.

3. Where new work meets existing, grades shall be adjusted to allow new work to meet and match existing finished grades at paved areas.

F. Excavation shall provide sufficient clearance for bracing, shoring, formwork, inspection and installations, as required.

G. The bottoms of all excavations shall be trimmed, by hand if necessary, to grades indicated or required.

H. The Contractor, at his option, shall make any exploration of the subgrade and areas requiring excavation as he may see fit, at his own cost and expense.

1. Prior to starting any excavation, the Contractor shall thoroughly familiarize himself with the location of all existing underground utilities that may be affected by his work.

2. All excavation within three feet of any existing underground utility line shall be accomplished by hand labor. Extreme caution shall be used in this area to prevent any damage to existing facilities.

3. All underground utilities and/or facilities uncovered or exposed shall be adequately protected by the Contractor, as necessary. Utilities serving existing facilities must not be interrupted until the Contractor has made the necessary arrangements with and received approval from the University.

I. All existing topsoil shall be removed to a depth of six inches and stockpiled on the site. All topsoil is the property of the University. Excess topsoil removed and not required for finish grading shall be removed by the Contractor and stockpiled as directed by the University at a location on University property.

J. Excavated materials to be used for filling may be stored at the site.

K. Excavated materials not required or not suitable for filling or other purposes shall be hauled from the site as excavated and disposed of off University property.

.02 Stockpiling, Furnishing, and Placing Topsoil

A. General

1. Intent:

a. The work in this section includes the labor, materials, and installation methods for the separation and salvaging of topsoil, furnishing of topsoil from an outside source and the placing of topsoil.

2. Protection of Existing Utilities

a. Prior to any work being performed the Contractor shall insure that all existing utilities within and surrounding the project site have been clearly marked in accordance with the Pennsylvania Underground Utility Line Protection Act, Act 287 as amended by Act 199.

3. Quality Assurance:

a. Topsoil shall consist of friable surface soils reasonably free of grass, roots, weeds, sticks, rocks or other unsuitable materials as determined under Part A.4. – Submittals.

4. Submittals:

a. Salvaged and Stockpiled Topsoil:

1) Prior to the start of any seeding activity, the Contractor shall have the existing soil tested by an approved soils testing laboratory. Copies of the soil test results shall be furnished to the University Representative prior to any grading, excavating, or other construction activity.

b. Furnished Topsoil:

1) The Contractor shall have the soil tested by an approved soils testing laboratory and shall make copies of the soil test available to the University Representative prior the hauling or delivery of any soil to the project site.

2) The Contractor shall submit a one-gallon sample, source, and letter of certification from the supplier to the University Representative for approval prior to installation.

5. Delivery, Storage, and Handling:

a. Stockpiling

1) Select a stockpile location to avoid slopes and natural drainageways, and to avoid traffic routes. Perimeter pollution controls shall be implemented as outlined in 31 01 00.01 – Earth Disturbance Management Guidelines and as outlined on the Erosion and Sedimentation Control Plan. Stockpiles shall not exceed 35’ above grade.

6. Job Conditions:

a. Areas where topsoil will be placed will be free of waste or debris developed by other trades. Any discrepancy from such conditions shall be reported to the University Representative before beginning any installation.

B. Materials

1. Salvaged and Stockpiled Topsoil: Acceptable friable loam that is reasonably free of subsoil, clay, brush, roots, weeds, other objectionable vegetation, stones, other foreign material larger than 2 inches in any dimension, litter, and/or other material unsuitable or harmful to the growing of vegetation.

2. Furnished Topsoil: Same criteria as outlined for Salvaged and Stockpiled Topsoil and containing not less than 2.0% or more than 10% organic matter. The soils shall be obtained from a site where the soil quality has proven ability to grow crops.

a. The Contractor is responsible for the reconditioning of the area from which the topsoil is obtained, and in accordance with all Local, State, and Federal regulations.

b. The contractor shall supply necessary documentation verifying that topsoil is free of contamination.

C. Execution

1. Protection of Existing Vegetation: All existing vegetation to remain shall be protected at all times in accordance with 32 90 00.01 – Tree Canopy / Tree Root Protection Zones.

2. Preparation of the Subgrade:

a. Using acceptable methods, the Contractor shall loosen the subgrade to a depth of 6 inches or otherwise required to provide adequate drainage before placing the topsoil. Remove stones and other foreign materials 2 inches or larger in any dimension. Remove and satisfactorily dispose of unsuitable and surplus material.

3. Spreading of Topsoil:

a. Spreading shall not be conducted when the ground or topsoil is frozen, excessively wet or otherwise in a condition detrimental to uniform spreading operations.

b. Topsoil shall be spread to the following depths:

(1) Turf Areas (Seed or Sod): Minimum depth of 6 inches as outlined in 31 01 00.01 (Lawns and Grasses) – Part C.2 – Topsoil.

(2) Planting Beds: Minimum depth of 12 inches as outlined in 31 20 00.02 (Trees, Shrubs, and Groundcovers) – C.2 – Topsoil.

4. Finishing of Topsoil:

a. The topsoil surface shall be left reasonably smooth and without ruts or surface irregularities that could contribute to concentrated water flow down slope or surface ponding conditions, Rake and grade planting beds.

b. Compact the topsoil enough to ensure good contact with the underlying soil, but avoid excessive compaction, as it increases runoff and inhibits seed germination and seedling growth.

c. All topsoil areas are to be finished in accordance with specified planting type for that area. Reference:

(1) 32 90 00.02 – Lawns and Grasses
(2) 32 90 00.03 – Trees, Shrubs, and Groundcovers
(3) 32 90 00.? – Herbaceous Perennials

D. Maintenance:

1. Once all topsoil areas have been finished and ready for planting and/or seeding, no vehicles will be allowed to drive on the placed topsoil at any time.

E. Inspections:

1. Pre-grading Inspection: Prior to the commencement of site work, contact the University Representative to provide an inspection to verify the delineation and protection of native soils and vegetation to remain in place, as outlined in 32 90 00.01 – Tree Canopy / Tree Root Protection Zones and 31 01 00.04 – Soil Protection Zones.

2. Interim Grading Inspection: Prior to the placement of topsoil, contact the University Representative to provide an inspection of the subgrade. Make corrections and adjustments as directed by the University Representative.

3. Post Grading Inspection: Prior to planting and/or seeding, contact the University Representative to provide an inspection to verify that the placement of soil and soil preparation is consistent with guidelines listed in this specification and on the grading plan. Make corrections and adjustments as directed by the University Representative.

4. Final Inspection: After all planting, seeding, sodding, paving, and/or other construction related activities are complete the Contractor shall contact the University Representative to provide an inspection to verify that all conditions are as stipulated in this specification. Make corrections and adjustments as directed by the University Representative.

5. Secondary Verification for Failing Sites: If the University Representative determines that the installation does not meet the conditions outlined in this specification or on the approved grading plan, additional testing by an independent soils

testing laboratory will be ordered by the University Representative and paid for by the Contractor. Make corrections and adjustments as directed by the University Representative.

F. Establishment Period:

1. All Establishment Periods pertaining to 32 90 00.02 – Lawns and Grasses, .03 – Trees, Shrubs, and Groundcovers, and .? – Herbaceous Perennials will pertain to the establishment of topsoil on the project site. If at any time during the 120 day Establishment Period it is determined that the topsoil does not meet the conditions outlined in this specification or on the approved grading plan, the University Representative reserves the right for additional testing, paid for by the Contractor, to determine the correct course of action.

G. Acceptance:

1. Final acceptance for soil preparation will be contingent on the approval of all inspections and that the soil preparation is consistent with these specifications and with the approved grading plan.

DIVISION 32 – EXTERIOR IMPROVEMENTS

32 00 00 EXTERIOR IMPROVEMENTS

32 01 00 General Requirements and Owner Intent

.01 Inspection and Testing

A. Continuous inspection and testing by a testing laboratory with a Soils Engineer as approved by the Professional shall be provided during filling and compaction. All footing excavations shall be inspected by a qualified inspector to ascertain that all excavations have penetrated topsoil, soil with organic matter, or fill to undisturbed soil; that the bottom of the excavation is on suitable bearing material; and that all loose material, water and water-softened material has been removed just prior to placing concrete. The Contractor shall contract and pay for the services of the testing laboratory and the Soils Engineer. Copies of the reports from the testing laboratory shall be forwarded to the Contractor, the University, and the Professional.

B. Compaction Tests (if required)

1. The Contractor shall employ a recognized testing laboratory, approved by the Professional, to perform verification testing of compaction.

2. The Professional and the University reserve the right to direct where tests shall be taken.

3. Certification of compliance from testing laboratory shall be provided to the Professional, which shall state that the earth compaction conforms to the requirements of these specifications. Certificates shall be received and approved by the Professional prior to concreting operations.

32 10 00 BASES, BALLASTS, AND PAVING

.01 Curbs and Gutters

A. Portland cement concrete curbs and gutters. The following specifications and standards of the issues listed are to be utilized.

1. Commonwealth of Pennsylvania Department of Highways (PennDOT) Specification Form 408, latest edition, as amended herein.

2. American Society for Testing Materials (ASTM).

B. All Portland cement concrete curb and gutter work shall be constructed in conformance with the latest edition PennDOT Specification Form 408, as amended herein:

1. Curb and/or curb and gutter shall be a monolithic pour with form or saw contraction joint 3/16" wide and 2" deep.

2. Concrete curb may be placed with an acceptable, self-propelled machine as approved by the University and in
accordance with PennDOT 408, Section 630.3(d). Comply with all curb and/or curb and gutter profiles and dimensions.

3. Wood or metal forms may be used at all locations.

4. Match curb and gutter profiles where new work is an extension or revision of existing.

5. See Curb Details 2-A and 2-B. Details are not yet available in WEB-based manual.

.02 <u>Portland Cement Concrete Paving-Section 02520</u>

A. The following specifications and standards of the issues listed are to be utilized:

1. Commonwealth of Pennsylvania Department of Transportation Specifications, Publication 408 and Supplements, latest edition, hereinafter referred to as Pub. 408.

2. American Society for Testing Materials (ASTM).

3. American Concrete Institute (ACI).

4. American Association of State Highway and Transportation Officials (AASHTO).

B. Before placing aggregate bed for cement concrete paving, check the subgrade and do all necessary grading, rolling, and compacting required to attain a true, even, firm surface. Fill and consolidate any traces of dented or depressed areas. Remove all spongy material, replace with suitable earthfill, and compact solidly with roller or mechanical compactors; moisten if required.

C. Provide a crushed aggregate bed fully choked and rolled to the compacted thickness indicated on the drawings.

Stone aggregate for base course shall be Type C, or better, 2A, and OGS as specified in Pub. 408, Section 703.2.

D. Cement Concrete:

1. Furnish Class A cement concrete mixture of Portland Cement, Type IA air-entraining cement, fine aggregate, course aggregate, and water as specified in Pub. 408, Section 704, Table A.

2. Cement to be air-entrained from an approved manufacturer as listed in Bulletin 15. Use cement for each project from the same manufacturer.

3. Cement content shall be a minimum of six (6) 94-lb. bags per cubic yard and a maximum of eight (8) bags per cubic yard.

4. Fine aggregate (sand) to be Type A. Do not use fine aggregate produced from limestone in concrete wearing surfaces. See Pub. 408, Section 703.1, Table A.

5. Course aggregate to be Type A, No. 57 as specified in Pub. 408, Section 703.2, Tables B, C, and D.

6. Water for mixing or curing shall be clean and free of all impurities detrimental to the cement concrete.

7. Concrete reinforcement shall be fibermesh or equal. Fibermesh materials shall be mixed at the rate of 1.5 lbs. of fiber to 1 cu. yd. concrete. Mix reinforcement with concrete a minimum of five minutes on the truck.

8. Cement concrete shall be designed with an entrained air content of 6% in the plastic state with a tolerance of +1.5 percent during the work. The specification for entrained air is met, if the entrained air in the hardened concrete is not less than 3.5 percent nor greater than 7.5 percent. Testing for air-entrained cement concrete shall be in accordance with Pub. 408, Section 704.1(c)1.

9. Cement concrete shall be mixed and transported in accordance with Pub. 408, Section 704.

10. Slump range at point of delivery shall be 1 inch to 3 inches. Test concrete for slump in accordance with Pennsylvania Test Methods (PTM) No. 600.

11. Compressive strength at 28 days shall be a minimum 3300 psi.

12. Proportions of ingredients shall be determined, and tests shall be conducted, in accordance with basic relationships and procedures outlined in Pub. 408 and Pennsylvania Test Methods (PTM) 601, 604, and 613.

13. See cement concrete walkway paving detail as shown. Details are not yet available in WEB-based manual.

E. Expansion Joints:

1. Use ¼" thick premolded expansion joint material the specified depth of the concrete slabs along all foundations and walls where slabs abut other fixed structures; longitudinally where sidewalk slab is to be constructed in contact with curb, and adjacent to existing structures as directed. Expansion joint material may be Isolation-Joint-Filler Strips – ASTM D 1751, asphalt saturated cellulosic fiber, or ASTM D 1752, cork, or self-expanding cork.

2. Sidewalks shall be constructed with expansion joints placed every 20' to 35' to accommodate scoring joint patterns. Expansion joint material shall be recessed ¼ inch from top of slab to allow for edging and sealants if specified or indicated. See also plan for scoring joint designs and expansion joint placement.

3. Where existing and/or new light standards, poles, fire hydrants, access frames and covers to underground utilities, manhole frames and covers, and similar structures are within the limits of the sidewalk areas, the concrete around such structure shall be scored, by edging and/or grooving, in a block 8" wider than the maximum dimensions of the structure at the sidewalk elevation. Prior to placing the concrete around such structures, premolded expansion joint material shall be placed around the structure to the full depth of the slab.

4. Unless otherwise directed by the University, a metal edger having a ¼" radius shall be used for edging all joints. Transverse and longitudinal scoring shall be done in accordance with the drawings and/or directed. Scoring and control joints shall extend to a depth of at least ¼ of the thickness of the concrete slab.

F. Forms:

1. Forms may be metal or wood, securely staked and braced, and constructed to true lines and shapes

indicated and extending the full depth of concrete.

2. Forms shall be oiled if metal or wetted or oiled if wood. Form oil shall be an approved form coating. Care shall be taken to prevent reinforcement from becoming coated with form oil.

3. Forms once used shall be thoroughly cleaned before being reused.

4. Side forms shall not be removed within 12 hours after the concrete has been placed. After the removal of forms, minor honeycomb at formed areas shall be filled with mortar composed of 1 part of cement and 2 parts of fine aggregate. Major honeycomb areas will be considered as defective work, and shall be removed and replaced at no additional cost to the University.

G. Placing Concrete:

1. All concrete work shall conform to referenced and applicable standards and the latest American Concrete Institute Manual of Concrete Practice.

2. Sidewalk slabs shall be one-course construction of thickness indicated on the drawings - in no case less than a full five (5) inches, unless otherwise specified on the drawings.

3. Do not increase the quantity of water in the concrete beyond the recommended design limit.

H. Weather Requirements:

1. Placement of concrete under extreme weather conditions shall take place only after approval from a University Landscape Architect.

I. Curing Requirements:

1. To insure adequate curing, forms for vertical surfaces shall not be removed sooner than 12 hours after casting concrete, unless other approved means are taken to prevent premature drying of the concrete.

2. All other unformed surfaces shall be protected from premature drying with liquid membrane-forming curing compound clear or white and also with white polyethylene sheeting:

   a. The clear and translucent shall contain a red fugitive dye and conform to AASHTO-M148, Type 1-D. The white pigmented compounds shall be

Type 1-D and Type 2 and certified as specified in Pub. 408, Section 106.03(b) 3.

Do not use white membrane-forming curing compounds after September 1 where deicing chemicals will be used the following winter.

b. White polyethylene sheets shall conform to AASHTO M171 and Pub. 408, Section 711.1.

3. Liquid membrane-forming curing compounds and polyethylene sheeting shall remain in place for a period of at least 96 hours after casting and finishing operations.

4. Temperature of the air in contact with concrete surfaces during this curing period shall be maintained at temperatures not lower than 50°F and not higher than 90°F.

J. Protection and Cleaning:

1. All finished concrete work shall be protected from damage due to subsequent construction operations. All concrete work from which traffic cannot be restricted shall be protected by use of approved covering, temporary ramps or walkways.

2. New construction adjacent to concrete work areas shall be protected from splashing and damage, by protective coverings of waterproof paper, plastic, and/or wood members as required.

K. Finishing of Concrete Sidewalks:

1. All cement concrete sidewalk slabs shall be placed to full thickness in one operation without change in proportions, rammed, spaded or vibrated, and screeded to proper grade, wood floated and lightly troweled with a steel trowel. When the concrete has set sufficiently, the slabs shall be given a coarse stiff bristle broom finish perpendicular to the line of traffic to produce a non-slip surface. See plan for other finishes.

.03 Exterior Concrete Steps

A. Steps should be built into the slopes and have a foundation below frost level. Risers shall have a backslope and treads shall have a 1/4" wash.

B. A general design formula for establishing size of risers and treads shall be twice the riser plus the tread = 26". Preferred riser dimensions are 5" minimum and 6" maximum.

C. Foundation wall at top and bottom of steps shall have a projecting ledge to support pavements.

D. Where feasible there shall be no fewer than 3 steps and no more than 10 steps per set.

E. Maintain 3" minimum clearance from edge of steps to outside of drilled hole for handrail installation where required.

F. Handrails, tread, and riser design shall meet all local and national codes and ADA requirements.

G. Treads shall have a non-slip finish.

H. Nosing bars shall not be used in step construction.

I. See Detail 2-D for additional information. Details are not yet available in WEB-based manual.

.04 Hot-Mix Asphalt Paving-Section 02511

A. General

1. Bituminous Concrete Paving:

a. Standard Specifications: The following specifications and standards of the issues listed are to be utilized:

1) Commonwealth of Pennsylvania Department of Transportation (PennDOT) Specifications, Publication 408 and Supplements, latest edition, hereinafter referred to as Pub. 408.

2) American Association of State Highway Transportation Officials (AASHTO).

b. Scope: Provide bituminous concrete paving at the areas indicated, including:

1) Subgrade preparation.

2) Subbase course.

3) Bituminous concrete base course.

4) Bituminous concrete surface course.

5) Bituminous tack coat.

6) Class A geotextile.

c. Regulations:

1) All work shall conform to all applicable codes, ordinances, and PennDOT regulations.

d. General Requirements:

1) Do all rolling with a power roller having weight of at least 10 tons. Use thorough hand or power tamping to obtain proper compaction of any areas not accessible to the roller.

2) The Contractor shall patch, repair, and/or replace all bituminous and concrete paving, curbs, and walkways disturbed, damaged, and/or affected by the installation and construction of all work within the contract limits, and any adjacent existing paving, curbs, inlets, or property damaged by the operation of the work for bituminous paving. All work shall be installed under the requirements of applicable sections as herein specified.

3) Protect adjacent work and structures from splashing of paving materials.

4) Protect paving against traffic until surface has properly cured as specified in Pub. 408, Section 401.3(n).

5) Provide temporary barriers, warning lights, and other protection as necessary.

6) Bituminous pavement and paving operation shall be in accordance with Pub 408, Section 401.

B. Products

1. Materials:

a. Subgrade Preparation:

1) The Contractor shall check the subgrade and verify that all conditions of the specifications have been met prior to installing any subbase material.

2) Provide for all required corrections to the subgrade before proceeding with the

work in accordance with Pub. 408, Section 210.

3) When acceptable subgrade density cannot be achieved or when subgrade displays pronounced elasticity or deformation during rolling or proofrolling, excavate material in the area to a depth that, when replaced and recompacted, the subgrade will have the required stability. Cutout areas shall be classified as Class-1A excavation in accordance with Pub. 408 Section 203.1 (b) and shall be backfilled using an acceptable material in accordance with Pub. 408 Section 206.

b. Subbase Course:

1) Provide a 2A crushed aggregate subbase course laid in courses fully choked and rolled to the compacted thickness indicated on the drawings.

2) Crushed aggregate subbase course shall be in accordance with Pub. 408, Section 350.

c. Bituminous Concrete Base Course (Standard):

1) Provide a base course of hot-mixed, hot-laid bituminous concrete over specified subbase course, in accordance with Pub. 408, Section 305.

d. Plant-mixed Bituminous Concrete Surface Courses:

1) Provide a bituminous concrete surface course in accordance with Pub. 408, Section 401.

2) Bituminous concrete surface course shall consist of a binder course and a wearing course constructed on specified base courses, as amended to meet details on the drawing and below.

a) Binder course shall be ID-2 (Standard) as specified on plan in accordance with Pub. 408, Section 421.

b) Wearing course shall be ID-2 (Standard) or FJ-1, as specified on plan in accordance with Pub.

408, Sections 420 and 422 respectively.

c) Resurface course shall be ID-2 (Standard) or FJ-1, as specified on plan. Wearing course to be thickness indicated on the drawing.

d) For walkway, FJ-1 shall be used. See separate walkway and roadway details for paving sections.

e. Bituminous Tack Coat:

1) Provide a bituminous tack coat over existing bituminous areas to be resurfaced in accordance with Pub. 408, Section 460.

f. Class A Geotextile:

1) Provide Class A Geotextile in accordance with Pub. 408, Section 212.

C. Execution

1. Installation:

a. Flexible Pavement:

1) Flexible pavement shall be constructed in accordance with Pub. 408, Section 401.

b. Milling:

1) Pavement notches shall be milled where new pavement meets existing pavement. The notch should be the full depth of the new wearing surface and shall extend 1 foot into the existing wearing surface. The joint shall be sealed with hot, bituminous material. Milling shall be in accordance with Pub. 408, Section 491.

c. Sealing:

1) When wearing course is placed adjacent to existing pavement at locations such as paving notches, curbs, lane additions, longitudinal joints, transverse joints, or utility openings, seal joint with hot, bituminous material in accordance with Pub. 408, Section 401.

d. Professional Note:

1) Service roads to buildings should be no less than sixteen feet wide with curve radii no less than thirteen feet.

2) All work shall be concrete unless otherwise specified.

3) See Bituminous Concrete Paving Details 2-E and 2-F. Details are not yet available in WEB-based manual.

.05 Stone Beds

A. Install stone beds in the following manner:

1. Remove existing earth and/or sod at location indicated to depth shown/noted on the drawings.

2. Plastic sheeting shall be 6 mil thick, black polyethylene installed over graded earth subgrade and shall extend 3 inches up the side of the abutting structures.

3. Install and anchor 2 x 6 pressure-treated lumber, flush with grade at perimeter edge of stone bed.

4. River stones shall be installed over the plastic sheeting, punctured for drainage, and shall be placed to depth and elevations indicated to level grade and provide neat appearance. Compact stone fill lightly by tamping and/or rolling to insure against future settlement and voids.

B. Stone shall be washed river stone varicolored, sized as specified on drawings, similar to mill-run river stone as produced by the Lycoming Silica Sand Company, Montoursville, Pennsylvania, or stone native to the area and approved by the University Landscape Architect.

32 90 00 PLANTING

.01 Tree Canopy/Tree Root Protection Zones

A. General

1. Intent:

a. The Pennsylvania State University is committed to tree protection.

b. The tree canopy/tree root zones shall be protected during the entire construction process.

c. Tree trunks and branches shall not be damaged by equipment and/or workers and tree root protection zones shall be protected from soil compaction, damage by trenching or excessive grade changes, and hazardous materials or waste products.

2. Protection of Existing Utilities:

a. Prior to any work being performed the Contractor shall insure that all existing utilities within and surrounding the project site have been clearly marked in accordance with the Pennsylvania Underground Utility Line Protection Act, Act 287 as amended by Act 199.

3. Submittals:

a. Prior to the start of any construction work the Contractor shall submit a Tree Canopy/Tree Root Zone Protection Plan. Development of this plan shall include input from the University Arborist and Project Manager or Assigned Construction Quality Representative. This plan shall be of the entire site showing accurate trunk locations and drip-line dimensions of all trees on the project site, limits of construction, locations of tree canopy/tree root protection zones, and indicating all appropriate protective measures.

b. The Contractor shall submit a written guarantee that he/she shall not enter the tree protection zones at any time during construction without first getting approval from the University Representative.

c. The Contractor shall verify in writing that all tree protection measures have been met as per the Protection Plan. Compliance with this plan shall be field verified by the University Representative.

4. Tree Canopy/Tree Root Protection Zones

   a. Prior to the start of any site work the contractor will erect fencing around trees which are to be preserved and sensitive tree root zones which are to be protected within the construction site.

   b. Trees indicated on the plan to remain shall be protected from injury to their branches, trunks, and root zones during the entire construction period. Protection of tree canopy/tree root zones shall be by the placement of temporary fencing as outlined in Part B.1.b – Materials.

      1) NO REMOVAL OR ENCROACHMENT INTO TREE PROTECTION ENCLOSURES SHALL BE PERMITTED UNLESS COORDINATED WITH THE UNIVERSITY REPRESENTATIVE.

   c. The Contractor shall be responsible for the installation and maintenance of all tree protection fencing. Protective fencing shall remain undisturbed until all construction activities have been completed. The Contractor shall remove fencing upon completion of construction.

      1) If protective fencing is damaged, the Contractor shall immediately execute the necessary repairs to re-establish the protective fencing to original configurations outlined on the Tree Canopy/Tree Root Protection Zone Plan.

      2) At the conclusion of the project, as tree protection fencing is being removed, the Contractor shall continue to identify and enforce tree canopy/tree root protection zones using temporary measures until final acceptance. The use of these temporary protection methods is only acceptable for a period not to exceed 5 business days. A list of appropriate materials and methods for temporary protection are listed in Part B.1.b – Materials.

      3) The Contractor shall be held liable for any damages to protected trees and root

zones caused by unauthorized intrusions into the protected areas during the construction period. Penalties to be enforced are outline in Part D – Liability.

d. Any pruning of trees that may be required during the course of construction shall be performed by the University Arborist and requests for pruning shall be made through the University Representative.

e. Erosion control devices shall be installed as per the contract drawings with particular emphasis on preventing silting, erosion, and/or damage within the tree root protection zone.

B. Materials

1. Equipment and Materials:

a. Equipment:

1) As selected by the Contractor, except as otherwise indicated, to complete work in a safe manner and to protect all personnel and bystanders involved.

b. Materials:

1) Protective fencing shall be 6 feet high chain link fence supported by 2 inch diameter galvanized iron posts set to a minimum depth of 2 feet. Posts shall be spaced a minimum of 10 feet on center and a 3 feet wide gate shall be provided to allow maintenance access to the protection zone. Movable fence panels may only be used upon approval from the University Representative.

2) An 8 ½" x 11" sign indicating the area as a tree protection zone shall be prominently displayed on each fence panel. Signs may be obtained by contacting the University Representative.

3) Temporary protection measures shall be strictly enforced at the conclusion of the project, up until final acceptance. These methods may include, but are not limited to the use of signs, post and wire, or other methods approved by the University Representative.

C. Execution

1. Scope of work within or around Tree Canopy Protection Zone:

   a. Trees to be removed that have branches extending into the canopy of trees to be preserved shall be removed under the continuous supervision of an arborist certified through the International Society of Arboriculture and not by a demolition or construction contractor. The Arborist shall remove the tree in a manner that causes no damage to the protected trees and landscape to remain after the construction period.

   b. Trees to be removed shall be felled so as to fall away from protection zones and to avoid pulling and breaking of roots or branches of trees indicated on remain on the Tree Canopy/Tree Root Protection Zone Plan.

   c. Any brush clearing required within or around the tree canopy/tree root protection zone shall be accomplished with hand operated equipment.

   d. The Contractor shall be held liable for damages incurred to any tree branches that extend over protective fencing and to any trees or other plant material located on the site and indicated on the plan to remain. The Contractor shall notify the University Representative when any overhanging branches or other plant material interferes with the construction activity or post potential risks to workers or bystanders.

   e. If plans and field situations do not match and work must occur closer to any existing tree (s) than planned, the Contractor shall notify the University Representative to evaluate and to determine future viability of the existing tree (s) located within the area of proposed construction or excavation. Final evaluations shall be coordinated with the University Landscape Architect and Arborist to determine if the tree (s) should remain, be relocated, or be removed.

2. Scope of work within or around Tree Root Protection Zone:

   a. Any grading, construction, demolition, or other work that is expected to encounter tree roots shall be made in consultation with the University Arborist.

1) Any digging that must occur within the Tree Root Protection Zone must be done with the University Arborist present and must utilize alternative excavation methods including, but not limited to air spading, hand excavation, metal plating or other method approved by the University Arborist.

b. Any roots 2 inches in diameter or less that sustain damage during construction shall be exposed to sound tissue and cleanly pruned close to the tree side of the excavation. Clean cuts shall be made at all times. The cutting of tree roots greater than 2 inches in diameter must be approved and supervised by the University Arborist.

c. Trees to be removed adjacent to the tree root protection zones shall be cut near ground level and the stump ground out to avoid damaging existing roots by pulling and breaking.

d. For those construction projects requiring temporary access or haul roads through the protection zone, a roadbed shall be installed using road plates, Alturnamat, or a PADOT Class IV Geotextile base covered with 6 inches (minimum) of mulch, wood chips or gravel to protect soil and minimize soil compaction. In those cases approval shall be given by the University Representative prior to the start of any construction activities. The roadbed material shall be maintained as necessary to maintain its original state.

e. No material shall be stored or piled within the tree root protection zone unless otherwise approved by the University Representative. No gasoline, fuel oil, harmful chemicals or other deleterious materials shall be stored, spilled or deposited on the ground within the tree root protection zone.

f. There shall be no vehicular traffic or parking permitted within the tree root protection zone.

g. Foot traffic shall be kept to a minimum within the tree root protection zone. If temporary foot traffic must be directed over the tree root protection zone a pathway shall be installed using Alturnamat or a PADOT Class IV Geotextile base covered with

3 inches (minimum) of mulch, wood chips or gravel to protect soil and minimize soil compaction. In those cases approval shall be given by the University Representative prior to the start of any construction activities. The pathway material shall be maintained as necessary to maintain its original state.

h. Installation of curbs and sidewalks shall be completed in a manner least damaging to trees and tree root systems. PADOT Class IV Geotextile shall be considered a viable alternative to the specified sub-base in sensitive root zones. When unique site conditions not addressed in the contract documents result in the opportunity for an alternative solution or a potential modification to the plan, the Contractor may present a proposal to the University Representative.

D. Liability:

1. The Contractor shall be held liable for any damage to protected trees. A dollar value shall be determined by the University Arborist or certified tree appraiser following criteria outlined in the "Guide of Plant Appraisal" (Council of Tree and Landscape Appraisal, Latest Edition).

2. The Contractor shall be held liable for all remedial measures required to treat broken limbs, or damaged trees and roots, or for the unauthorized removal of existing trees or plant material. All remedial treatments will be accomplished by the University Arborist and/or their designee.

.02 Lawns and Grasses

A. General

1. Intent:

a. The work in this section specifies the labor, materials, and installation methods necessary to establish the highest quality turf areas.

2. Protection of Existing Utilities

a. Prior to any work being performed the Contractor shall insure that all existing utilities within and surrounding the project site have been clearly marked in accordance with the Pennsylvania Underground Utility Line Protection Act, Act 287 as amended by Act 199.

3. Submittals:

   a. Prior to the start of any seeding activity, the Contractor shall have the existing soil tested by an approved soils testing laboratory. Copies of the soil test results shall be furnished to the University Representative prior to any grading, seeding, or sodding.

   b. The Contractor shall submit a Percolation Rate Test prior to the commencing of any seeding activity. This test is intended to determine the rate of percolation of the existing subgade.

   c. The Contractor will provide an inspection certification indicating the origin and health of seed and/or sod material.

      1) Seed must be Blue Tagged Certified Seed and must contain requirements indicated in PART B.7 – LAWN SEED. The Contractor shall submit seed breakdown tags to the University Representative for approval. Tags will show percentage of seed varieties, weed seed, inert matter, and date of "Germination Test" done within a nine-month period prior to sale of the seed.

      2) Sod must be certified and must contain requirements indicated in PART B.8 – LAWN SOD.

   d. The Contractor shall provide submittals indicating the type and application rates of fertilizers as recommended in accordance with the soil test.

   e. Chemical Spraying Program: No spraying of herbicides, insecticides, fungicides, nematicides, fumigants, or other chemicals shall be done without first submitting a spray program to the University Representative. Application of herbicides will only be permitted by licensed applicators. Applicators should follow all notification requirements of the University and consult any Chemical Hypersensitivity Registries for the area.

4. Delivery, Storage, and Handling:

   a. Seed

      1) Each seed container shall be in sealed bags labeled by manufacturer and/or grower and indicating weight and analysis.

      2) Bulk deliveries of seed shall be accompanied with delivery tickets specifying percentage of germination, purity, and noxious weed content.

      3) Seed shall be kept in dry storage away from contaminants, insects, and rodents.

   b. Sod

      1) All sod shall be reviewed by the University Representative at the job site prior to installation. The University Representative reserves the right to reject any sod they deem unacceptable.

      2) All sod delivered from the supplier shall be installed on the same day as delivery.

      3) Each palette, flat, or specified group of sod shall be labeled by the grower or manufacturer as separate items.

      4) During delivery and storage, sod materials shall be protected from any drying or contamination by detrimental material.

      5) Sod shall not be dropped or dumped from vehicles.

   c. Fertilizer and Lime: Each container of fertilizer and/or lime shall be labeled by manufacturer as separate items indicating weight and analysis of the container.

   d. Topsoil: Topsoil shall not be muddy or frozen at time of grading.

5. Job Conditions:

   a. Turf areas will be free of waste or debris developed by other trades. Any discrepancy from such conditions shall be reported to the University Representative before beginning any installation.

6. Grading and Topsoil:

   a. The Contractor shall grade all turf areas indicated on the drawings. In the event there are discrepancies between the construction drawings and on-site conditions, the Contractor shall notify the University Representative before beginning any installation.

   b. The Contractor shall remove all topsoil and stockpile it on site. All topsoil is the property of the University. Excess topsoil removed and not required for finished grading shall be removed by the Contractor and stockpiled as directed by the University Representative at a location on University property.

7. Planting Season:

   a. Seeding: The planting of turf seed specified on the drawings shall be performed during the following timeframe: Between April 1st and May 15th or between September 1st and October 15th.

   b. Sodding: The planting of turf sod specified on the drawings shall be performed during the following timeframe: April 1st to October 31st.

B. Materials

1. Quality Assurance:

   a. Seed

      1) Seed Producer: Manufacturer specializing in grass seed production with minimum of 5 years' experience and certified by the Pennsylvania Department of Agriculture as outlined in Title 3 (Agriculture) of the Pennsylvania Consolidated Statutes.

      2) Seed: Must comply with all Commonwealth of Pennsylvania seed certifications.

   b. Sod

      1) Sod Producer: Manufacturer specializing in sod production and harvesting with minimum of 5 years experience and certified by the Pennsylvania Department of Agriculture as outlined in Title 3 (Agriculture) of the Pennsylvania Consolidated Statutes.

2) Sod: Minimum age of 18 months with root development that will support its own weight, without tearing, when suspended vertically by holding upper two corners.

2. Commercial Fertilizers: In accordance with the soil test recommendations, fertilizer shall be in bags showing weight, analysis, and manufacturer's name.

3. Lime: In accordance with the soil test recommendations, lime shall be high magnesium ground limestone containing not less than 85 percent total carbonates, 95 percent passing a 20-mesh sieve, 40 percent passing a 60-mesh sieve and a minimum of 30 percent passing a 100-mesh sieve.

4. Organic Amendments: In accordance with the soil test recommendations, organic matter shall be recycled composted leaf mulch, reed sedge peat and/or peat moss.

5. Topsoil: Topsoil will be provided in accordance with Section 2.13 – Stockpiling, Furnishing, and Placing Topsoil.

6. Herbicides: Non-selective herbicide shall be Round-Up as manufactured by Monsanto or approved equal and shall only be applied in accordance with the Chemical Spraying Program.

7. Lawn Seed:

   a. Shall be clean and fresh, packed in sealed bags showing net weight, composition of mix, date of germination tests and supplier's name.

   b. Seed must be Blue Tagged Certified and must not contain more than 0.1% by weight weed seed, no more than 1.5% inert matter, no more than 0.1% other crop seed and no noxious weed seed or undesirable grass species.

   c. Composite of the mix shall contain 60% bluegrass, 20% fine fescue, and 20% ryegrass. The varieties are stated as follows and no substitutions of mixes and/or percent of mixes is allowed.

Bluegrass: A maximum of 20% of each variety to total 60%. (Three different varieties)

-America	-Langara
-Award	-Midnight II
-Awesome	-Nudestiny
-Beyond	-Nuglade
-Freedom II	-Quantum Leap

Fine Fescue: A maximum of 10% of each variety to total 20%. (Two different varieties)

-Banner III	-Reliant II
-Bridgeport	-Rescue 911
-Brittany	-Shadow II
-Jasper II	-Treazure
-Longfellow II	-Victory II

Perennial Ryegrass: A maximum of 10% of each variety to total 20%. (Two different varieties)

-Applaud	-Hawkeye
-Cadence	-Jet
-Caddieshack	-Mach I
-Cutter	-Manhattan III
-Fiesta III	-Topgun

8. Lawn Sod:

   a. Sod type to be a Kentucky bluegrass blend consisting of 3 different varieties.

   b. Sod shall be field grown in same climatic conditions as that of the project site.

   c. Sod shall be strongly rooted, not less than 18 months old, free of weeds and undesirable native grasses. Sod must be capable of growth and development when planted.

   d. Sod shall be installed within 36 hours from the time it is cut.

9. Wood Cellulose Fiber Mulch:

   a. Shall consist of especially prepared wood cellulose processed into a uniform fibrous physical state.

   b. Shall be dyed green or contain a green dye in the package that will provide an appropriate color to facilitate visual inspection of the uniformly spread slurry.

   c. Shall contain no germination or growth inhibiting factors.

d. Shall be manufactured and processed in a manner that the wood cellulose fiber mulch will remain in uniform suspension in water under agitation and will blend with other additives to form a homogeneous slurry.

e. Shall form a blotter-like groundcover, on application, having moisture absorption and percolation properties and shall cover and hold grasss seed in contact with the soil without inhibiting the growth of the grass seedlings.

f. Shall not contain elements or compounds at concentration levels that will be phyto-toxic.

g. Must conform to the following physical requirements.

1) Fiber length to approximately 10 mm. Diameter approximately 1 mm.
2) pH range of 4.0-8.5
3) Ash content of 1.6% maximum
4) Water holding capacity of 90% minimum

C. Execution

1. Site Preparation

a. Grading:

(1) Prior to commencing any finished grading the Contractor shall notify the University Representative allowing enough time for a thorough inspection of the subgrade.

(2) Prior to any work the Contractor shall have all utilities located by calling PA One-Call at (800)242-1776.

(3) Prior to grading, apply Round-Up or other approved herbicide as per the manufacturer’s directions to eliminate any existing weeds. Allow sufficient time for the herbicide to take effect.

(4) Perform all finished grading necessary to bring site to required finished elevations indicated on the grading plan.

(5) If the general area is hard pan, the sub-grade shall first be rototilled or chisel plowed at least 12 inches deep to permit proper loosening, drainage, and

preparation of the ground. The sub-grade shall be loosened and graded by harrowing, discing, or dragging, as dictated by the condition of the sub-grade. The entire sub-grade shall then be raked and all stones over 1 ½ inches, grade stakes, rubbish, and general debris removed.

b. Topsoil:

1) Use topsoil stockpiled on the site during earthwork operations and provide any additional topsoil, at no additional cost to the University, as required on the Grading Plan and as outlined in Section 2.13 – Stockpiling, Furnishing and Placing Topsoil.

2) Topsoil shall be spread with approved equipment to a minimum depth of 6 inches to permit 1 inch settlement. Any surface irregularities shall be corrected to prevent the formation of low spots and pockets that would retain water.

3) Topsoil shall not be placed when the subgrade is frozen, excessively wet, or extremely dry, and no topsoil shall be handled when in a frozen or muddy condition.

4) During the preparation for seeding and/or sodding all stones over ½ inch in any dimension or any other rubbish, debris, or other materials which would be detrimental to seeding, sodding, or turf maintenance will be removed.

5) After completion of topsoil placing and approval of finish grading, remove any excess topsoil from the site and deliver to location determined by the University Representative.

6) Leave finish graded area clean and well raked, ready for lawn work.

c. Preparation of Surface for Seeding and Sodding:

1) Apply lime and basic fertilizer if required by the soil test at the recommended rate.

2) Immediately after lime and fertilizer application go over the entire area with a rototiller, or other approved piece of equipment and loosen surface at least 3 inches deep and then hand rake to a smooth even surface.

3) Spread starter fertilizer uniformly at the rate determined by the soil test for new lawns.

4) Add organic matter at the rate required by the soil test.

2. Execution of Work for Seeding:

a. As soon as the ground has been properly prepared and approved for seed by the University Representative, sow grass seed at the rate of 6 lbs. per 1,000 sq. ft., total, in two operations at right angles to each other, using a suitable mechanical seeder or sowing by hand for small areas.

b. Unless the seeder covers the seed with soil as it sows, rake to obtain a light covering of soil over the seed after sowing, then roll very lightly with an empty water roller.

c. Do no seeding in adverse weather or in wet conditions.

d. After seed application, wood cellulose fiber mulch shall be applied at a net dry weight of 1,500 lbs. per acre. The wood cellulose fiber mulch shall be mixed with water, and the mixture shall contain a maximum of 50 lbs of wood cellulose fiber per 100 gallons of water. In areas where erosion may be a problem, use an organic tackifier such as CON-TACK™, erosion fabric, or approved equal in accordance with the manufacturer's instructions.

3. Execution of Work for Sodding:

a. Lay sod on the same day as delivery to prevent dehydration.

b. Lay sod tight with no open joints visible, and no overlapping. Stagger end joints 12 inches minimum. Do not stretch sod pieces.

c. Lay smooth and align with adjoining grass areas. Place top elevation of sod ½ inch below adjoining edging, paving, or curbs.

d. On slopes exceeding 2 horizontal to 1 vertical, lay sod perpendicular to the slope and secure every row with wooden pegs at maximum of 2 feet on center. Drive pegs flush with soil portion of the sod.

e. Water sodded areas immediately after installation, saturating the sod to 3 inches of soil.

f. After sod and soil have dried, roll sodded areas to ensure a good bond between sod and soil and to remove minor depressions and irregularities.

D. Maintenance (Seed and Sod)

1. All lawn areas shall be maintained until August 31, 2007.

2. All lawn areas shall be kept moist to maximize germination and root establishment. Water shall be applied frequently enough to keep the grass and soil from drying out. The University shall provide the water source. The contractor is responsible for all hoses, sprinklers or other watering devices and he/she shall ensure proper backflow protection on the water source.

3. All areas and spots which do not show a prompt catch of grass or signs of browning shall then be reseeded or re-sodded as required until complete coverage is obtained.

4. When the average height of the grass is 3 to 4 inches, grass shall be cut to 2 to 3 inches or 1/3 of the grass blade. Any depressions or irregularities in the lawn surface shall be leveled off and reseeded or re-sodded.

5. Maintenance shall cease after the third cutting and final acceptance by the University Representative, provided all grass areas are properly established and free of washouts, depressions, bare spots, weeds and large off-color areas. If seeding or sodding is completed in the autumn, the Contractor shall complete the three cuttings in the following spring as required.

E. Final Inspection and Acceptance:

1. At the end of the maintenance period, an inspection will be made by the University Representative and the Contractor. Any lawn area under this contract that is not in satisfactory condition, as determined by the University

Representative, shall be reworked as soon as conditions permit. All reworked lawn areas shall be maintained as previously specified in PART D – MAINTENANCE until final inspection and acceptance occurs.

.03 Trees and Shrubs-Section 02955

A. Plants and Planting:

1. General

a. Intent:

1) The work in this section describes the labor, materials, and installation requirements necessary to complete tree, shrub, and groundcover planting with the highest possible quality standards.

b. Protection of Existing Utilities:

1) Prior to any work being performed the Contractor shall insure that all existing utilities within and surrounding the project site have been clearly marked in accordance with the Pennsylvania Underground Utility Line Protection Act, Act 287 as amended by Act 199.

c. Submittals:

1) Guarantee: Written guarantee warranting the plant material to be in healthy condition at the time of expiration of the 120 day "Landscape Establishment Period".

2) Soil Test: Prior to the start of any planting activity, the Contractor shall have the existing soil tested by an approved soils testing laboratory. Copies of the soil test results shall be furnished to the University Representative prior to any grading or planting.

3) Planting Schedule: Submit planting schedule showing dates for planting in each area of the project site.

4) Plant Substitutions: Plant substitutions will be permitted only upon approval by the University Landscape Architect and/or their designee.

5) The Contractor shall submit, in writing, a plant list outlining the source for all plants, their estimated delivery date, and length of time plants are to be stored at an off-site location.

6) Chemical Spraying Program: No spraying of herbicides, insecticides, fungicides, nematicides, fumigants, or other chemicals shall be done without first submitting a spray program to the University Representative. Application of herbicides will only be permitted by licensed applicators. Applicators should follow all notification requirements of the University and consult any Chemical Hypersensitivity Registries for the area.

d. Delivery, Storage, and Handling:

1) The Contractor shall contact the University Representative 24 hours prior to the delivery of any plant material.

2) All plant material shall be inspected by the University Representative at the job site upon delivery. Only plants approved by the University Representative shall be stored or planted. The University Representative reserves the right to refuse any plant material they deem unacceptable. Any and all rejected plant materials shall be removed from the job site on the day of rejection.

3) Each tree, shrub, groundcover flat, container of fertilizer or other construction material shall be labeled by grower or manufacturer as separate items.

4) Plant identification labels shall be durable and waterproof. Labels shall be securely attached to plants, bundlers, or containers of plants and shall state the correct botanical plant name and size. Labels shall not be removed from the plants until final acceptance.

5) Bulk deliveries of mulch, topsoil, and inert material shall be accompanied with delivery tickets showing weight, origin, and composition and stored in such a

manner as to prevent the inclusion of foreign materials.

6) Plant Storage: Trees, shrubs, and groundcovers not installed on the day of delivery to the site shall be stored and protected. NO PLANTS SHALL BE STORED ON THE SITE FOR A PERIOD GREATER THAN 5 BUSINESS DAYS. Storage locations shall be continually shaded and protected from the wind. Plants stored on the project site shall be protected from drying at all times, covering the balls or roots with moist woodchips, shredded bark, peat moss or other suitable heel-in material.

e. Job Conditions:

1) Planting areas shall be free of waste or debris developed by other trades. Any discrepancy from such conditions shall be reported to the University Representative before beginning any installation.

f. Planting Season:

1) General: No plants are to be planted when the ground is frozen or during days of extreme heat (≥80 degrees). Plants shall be installed between March 1st and June 15th or from August 15th until the ground freezes. Any change from this planting season must be approved by the University Representative.

2. Materials

a. Quality Assurance:

1) Plants shall be of the quantity and quality indicated, true to name, properly labeled with scientific name and in accordance with the sizes and grades specified. Plants shall be nursery grown, have a habit of growth that is normal for the species, and shall be sound, healthy, vigorous, free from insect pests, plant diseases and injuries, and shall have normal root systems. All plants shall equal or exceed the measurements specified in the plant list.

2) Plants shall be measured before pruning, with branches in normal position. Any

necessary pruning shall be done at the time of planting.

3) Requirements for the measurement, branching, grading, quality, balling, and burlapping of plants shall follow the code of standards currently recommended by the American Association of Nurserymen, Inc., in the American Standard for Nursery Stock, ANSI Z60.1, current edition.

b. Commercial Fertilizers: In accordance with the soil test recommendations, fertilizer shall be in bags showing weight, analysis, and manufacturer’s name.

c. Organic Amendments: In accordance with the soil test recommendations, organic amendments shall be compost, dark brown in color and humus like. Parent material should not be visible, particle size shall be less than or equal to ½ inch, and the pH range shall be 6.5-8.5.

d. Herbicides:

1) Non-Selective herbicide shall be Round-Up™ as manufactured by Monsanto or approved equal.

2) The spraying of all herbicides must be done in accordance with the Chemical Spraying Program.

e. Staking and Guying: Tree stakes shall be two 2”xs” stakes, a minimum of 6 feet long with 2 feet in ground. Guying shall consist of nylon straps wrapped loosely around the trunk.

f. Plant Material: All plant material shall conform to ANSI Z.60.1.

1) Balled and Burlapped Plants: Shall have balls of earth of sufficient diameter to be in accordance with the size of the plant, of sufficient depth to include an adequate root system, and shall be properly balled, burlapped, and secured.

2) Container Grown Plants: Shall be healthy, vigorous, well rooted, and established in the container in which they are sold. Plant development shall be sufficient so that they root mass will hold together when removed from the

container. Remove plastic containers before planting.

g. Grading and Topsoil:

1) The Contractor shall furnish all grading and topsoil as required by the "Grading Plan" and in accordance with 31 20 00.02 – Stockpiling, Furnishing, and Placing Topsoil.

h. Mulch:

1) Organic Mulch: Shall be coarse, fibrous, shredded hardwoods, free of dyes, sufficiently aged to prevent adverse reactions to plant material and subject to approval by the University Representative.

3. Execution

a. Protection of Existing Vegetation: All existing vegetation to remain shall be protected at all times in accordance with 23 90 00.01 – Tree Canopy / Tree Root Protection Zones.

b. Site Preparation:

1) Grading:

a) Prior to commencing any finished grading, the Contractor shall notify the University Representative allowing enough time for a thorough inspection of the subgrade.

b) Perform all finished grading necessary to bring site to required finished elevations indicated on the grading plan and to allow for positive drainage.

2) Topsoil:

a) Use topsoil stockpiled on the site during earthwork operations and provide any additional topsoil required.

b) Topsoil shall not be placed when the subgrade is frozen, excessively wet, or extremely dry, and no topsoil shall be handled when in a frozen or muddy condition.

c) After completion of topsoil placing and approval of finish grading by the University Representative, remove any excess topsoil from the site and deliver to location determined by the University Representative.

d) Leave finish graded area clean, well raked, and ready for planting.

c. Planting Layout:

1) Layout of plants prior to planting shall be verified by the University Representative. Any alterations to the planned planting layout must be approved by the University Landscape Architect and/or the designer.

d. Planting Bed Preparation:

1) The grouping of two or more plants shall constitute a planting bed or area. All unwanted vegetation shall be completely removed and hauled off site or sprayed with herbicide, in accordance with Part A.3.f – Chemical Spraying Program, to ensure that planting beds are completely weed free.

2) If groundcover of a type normally specified in flats or pots of a 1 gallon size or smaller is specified, the soil in the entire planting bed area will be loosened by rototilling or similar means to a depth of 6 inches.

e. Planting Pit Excavation:

1) All planting pits shall be excavated to the depth of the existing root ball and planted on undisturbed soil. All construction debris such as plaster, concrete, stone, brick, wood, or other deleterious materials shall be removed.

2) All tree pits shall be excavated circular with vertical sides. The diameter of pits for trees and B&B shrubs shall be at least 2 feet greater than the diameter of the rootball or spread of roots. Soil used in the planting shall be good grade topsoil, as specified, mixed with the surrounding existing soil. Poor soils, gravel,

hardpan, or other soil injurious to plants shall not be used.

3) If an impervious, hard pan layer remains in the bottom of the pit after excavation the University Representative shall be notified prior to any additional planting activities to inspect the excavation and develop an alternate course of action.

f. Planting:

1) General: The plant shall be set in its planting pit in such a manner that allows the bottom of the trunk flare to set 1 inch above finished grade. NOTE: THE TOP OF THE ROOTBALL IS NOT NECESSARILY THE BOTTOM OF THE TRUNK FLARE.

2) Bare Root: Build a cone of soil in the bottom of the planting pit. Place the plant in the hole, spreading the roots around the surface of the cone of soil. Gently backfill, firming the soil as you go.

3) Balled and Burlapped: Once the plant is set in its planting pit and at proper grade in relation to the surrounding soil, the Contractor shall remove all wire, twine and burlap or other deleterious material.

4) Containerized: When the Contractor removes the root ball from its container he/she shall inspect the root ball thoroughly for circling or girdling roots. The root ball shall then be scored to discourage girdling and to promote the growth of feeder roots.

g. Backfilling:

1) Use specified backfill medium around the roots, filling the hole about two thirds full, and firm the soil around the root ball and/or roots.

2) Water the plant well immediately after backfilling to insure proper settling of soil around the roots. Allow the water to soak down and fill the remainder of the hole with loose soil without further packing or tamping. A mound of soil

shall be formed around the edge of each tree pit to form a shallow saucer.

h. Pruning:

1) Prune all dead or broken branches at the time of planting.

i. Mulching:

1) Mulch all plants and planting beds or areas with a 3 inch layer of specified mulch. It shall entirely cover the area of the planting pit, bed, or saucer around each plant. DO NOT MULCH NEXT TO THE MAIN STEM OF THE PLANT.

j. Staking and Guying:

1) Staking and guying shall be done immediately after trees are planted using specified staking materials.

2) Trees shall stand plumb prior to staking.

4. Maintenance:

The Contractor shall be responsible for providing the following maintenance on all newly planted trees, shrubs, groundcovers, and herbaceous perennials.

a. Watering: During periods of inadequate rainfall, as determined by the University Representative, all plant material shall be watered to maintain a constant suitable moisture level for adequate plant growth. The Contractor shall be responsible for providing all watering hoses and other watering devices. The University will provide the water source.

b. Insect, Disease, and Weed Control: Weed control shall be by mechanical or hand weeding. The use of herbicides, insecticides, fungicides, nematicides, fumigants or other chemicals are only acceptable upon approval by the University under the provisions in Part A.3.f – Chemical Spraying Program.

5. Establishment Period

a. The Establishment Period will begin upon notice of substantial completion by the Contractor and inspection by the University

Representative and will last for a total of 120 days during the growing season. The growing season is defined as the period between April 1st and November 1st. If planting occurs in the autumn, the Establishment Period will carry over to the next growing season until a total of 120 days have been established.

b. Plants shall be guaranteed during the Establishment Period and shall be alive and in satisfactory growth at the end of that period. Plants which die within the establishment period will be removed by the Contractor within five (5) business days of notice or the University will remove the plants and bill the Contractor accordingly. Replacement plants may be installed during the next appropriate planting season for the species specified. All replacements shall be plants of the same kind and size specified in the plant list. They shall be furnished and planted according to all previous specifications noted and shall be guaranteed through an additional 120 day Establishment Period, as outlined above. The cost of replacement shall be borne by the Contractor, except for possible replacements resulting from removal, loss or damage due to vandalism, or act of neglect on the part of others.

c. The Contractor is responsible for all maintenance activities, including watering, weeding, insect and disease control or other methods required to insure the overall health of the plants during the Establishment Period.

6. Final Inspection and Acceptance:

a. At the end of the Establishment Period, an inspection will be made by the University Representative and the Contractor. Any plant determined to be of insufficient quality or unsatisfactory growth, as determined the University Representative, shall be removed from the site and replaced at the Contractor’s expense, as outlined in Part E.2 – Establishment Period.

DIVISION 33 – UTILITIES

33 00 00 UTILITIES

33 01 00 General Requirements and Owner Intent

.01 General

A. All new construction or renovation projects which necessitate modification of or an addition to existing utility systems must be coordinated with and approved by Engineering Services in the Utilities Division of OPP.

B. Instructions to Professionals

1. Once-thru cooling using potable water is not permitted on any equipment.

2. Planning Modules (PADEP Chapter 71) are required for any project when new flows are projected. The Professional shall obtain the standard planning module documents from PADER and complete them for processing. Documents will be submitted to Engineering Services for review and approval. If the project will discharge to a PSU Waste Water Treatment Plant, it requires a letter of documentation by PSU that the conveyance and treatment facilities have adequate capacity to accept the additional sewage flows generated by the specific project.

   Following approval of Engineering Services, the Project Manager shall direct submission to the appropriate municipality with the proper request for resolution and submittal to PADER.

   Approval by PADER is required prior to commencement of project construction.

3. The Utility Demand and Consumption form (Detail 15G-H) shall be completed by the Professional for every project. The information will be used to evaluate the impact on the existing distribution systems, and to request operating funds for the facility. The consumption data should be estimated as accurately as possible, and provided with the final design submission.

4. All piped utilities (water, storm, and sanitary) serving more than one building shall be designed to be fully accessible for maintenance. These utilities shall not be designed to be located under buildings.

5. All piped utilities shall include a continuous #10 wire installed with the utility line to be used for future locates.

    a. Wires shall extend above grade and shall terminate at a building wall, the top of catch basins or manholes, or similar, visible locations. Precise location of termination shall be approved by Engineering Services.

    b. Tracer wiring shall be installed with all utility lines, regardless of material or service. Where multiple electrical conduits are installed in a single concrete ductbank, only one tracer wire shall be installed per ductbank.

6. Supporting calculations shall be provided for all designs and studies to the Office of Physical Plant at their request. The professional shall keep all information available for a period of no less than five (5) years from the project’s completion.

7. All plans must contain a note on the cover sheet indicating that all new utilities must be “as-built” surveyed and the surveys must be provided digitally in AutoCAD format to the University.

C. Instructions to Contractors

1. Utilities serving existing buildings, installations, or facilities shall not be interrupted until the Contractor has made the necessary arrangements with, and has received approval from, the University.

2. In the event that interruption of any existing utility service is necessary, the responsible Contractor shall be required to make all the arrangements for shutdown and start-up of such service with the University representative.

3. University crews must be used to shut down and start up all University owned services which require interruption for temporary or permanent connections.

4. All planned interruptions to University services must be scheduled two (2) weeks in advance and the work will generally be done outside of normal working hours.

5. The Contractor shall provide a certification that all plumbing materials are lead-free and meet the

requirements of the Pennsylvania Plumbing System and Lead Ban Notification Act where the building will be serviced by a University water system (University Park, Mont Alto, and Wilkes-Barre Campuses). This certification shall be signed by the Contractor, notarized, and submitted to the University before the water service is turned on. Return completed form (see Figure 15G-I) to Director, Utilities Division, Office of Physical Plant.

6. The consultant must provide digital (AutoCAD) as-built surveys of the all new utilities to the University. Red line mark-ups are not acceptable.

.02 Temporary Utility Service

See Section F, General Conduct of the Work and Special Requirements.

33 10 00 WATER UTILITIES

.01 Water

A. Distribution Systems

1. Building service sizing, including meters, valves, etc., shall be performed by the Engineer of Record.

2. Waterlines

a. Waterlines three inches in diameter and greater shall be ductile iron pipe meeting all requirements of ANSI/AWWA C110/A21.10 and ANSI/AWWA C111/A21.11. The class for ductile iron pipe shall be thickness Class 52. Fittings shall be Class 350#, ductile iron compact or full body mechanical joint fittings. All ductile iron pipe and fittings shall be double cement lined and coated outside with a bituminous seal coat all according to ANSI/AWWA C104/A21.4 and ANSI/AWWA C151/A21.51 respectively. All pipe shall be push-on joint type with gasket conforming to ANSI/AWWA C111/A21.11 and shall be American Pipe Flex-Ring/Field-Loc, Fast-Grip gasket or equal as approved by Engineering Services.

b. Waterlines smaller than three inches in diameter shall be copper service tubing conforming to the requirements of ASTM

Designation B88, Type K, heavy wall, soft temper. Copper service lines shall have grip joint-type fittings.

c. Mechanical joint restraint shall be accomplished by the utilization of joint restraints ("Megalugs") with adequate concrete thrust blocks as approved by both the National Board of Fire Underwriters "Standard for Outside Protection" and Penn State Engineering Services.

d. Provide air release/vacuum break at all high points in new distribution piping. Refer to Detail 15G-E. Details are not yet available in WEB-based manual.

e. All water lines shall be designed to be a minimum of 4 feet and a maximum of 8 feet below finished grade. The trench shall be backfilled on the bottom and sides of the pipe to a height of one foot above the top of the pipe with crushed stone dust. The remaining backfill material shall be earth, free of wood, ashes and other debris, but may contain rock pieces not larger than one cubic foot in volume, but consisting of not more than twenty-five percent rock by volume. No other material shall be used as backfill.

f. Provide adequate thrust blocks.

3. Water Meters

a. The water flow to each building shall be metered with a cyclometer counter giving a direct reading in gallons. All meters larger than 2" shall be compound meters. A touch read remote transmitter shall be provided and the counter located in an approved location.

b. Meters shall conform to AWWA Standard. A full-size bypass shall be provided around the meter to allow for servicing. Refer to Detail 15G-G. Details are not yet available in WEB-based manual. Provide a meter manufacturer recommended strainer with each meter.

1) At locations served by the University Park Utility Water Services system, meter and associated strainer shall be provided by Utility Services for installation by the contractor.

2) At all other locations, meter manufacturer shall be Neptune, unless otherwise required by the local water authority.

4. Valves - Underground

a. Gate valves shall be manufactured in accordance with ANSI/AWWA C509. The type shall be RESILIENT SEATED and shall have a nonrising stem. THE DIRECTION TO OPEN SHALL BE COUNTERCLOCKWISE. The operating nut shall be two inches square. Valves shall have ends suitable for use with mechanical joint pipe. Exterior of valve shall be coated with bituminous seal coat.

b. Valve boxes shall be cast iron of the three piece screw type installed over the bonnet and operating nut, and of sufficient length to reach the surface of the ground but not extend above the ground surface. The word "water" shall be cast in valve box lid.

5. Constant Pressure Pumps

See Division 22 00 00.

B. System Tests and Disinfection

1. Testing shall conform to AWWA C-600.

2. Disinfection shall conform to AWWA C-651. Contractor shall retain the services of a PaDEP certified water testing laboratory to sample and test the potable water system. All test results shall be provided to Utility Services prior to activation of services by Utility Services.

3. Meter and backflow prevention device shall be installed and inspected by Utility Services prior to service activation.

C. Fire Hydrants

1. At University Park Campus, fire hydrants shall have National Standard threads. Fire hydrants shall conform to AWWA C-502. Fire hydrants shall have 2-2 1/2" hose outlets and one 4 1/2" pumper connection. Hydrants shall be American Darling No. B-62-B-5 fire hydrants with traffic feature, or other as approved by Utility Services.

2. At locations other than University Park Campus, coordinate threads and outlet size with fire department serving that location. Hydrants shall be American Darling No. B-62-B-5 fire hydrants

with traffic feature, or other as approved by Utility Services.

3. Refer to Detail 15G-F. Details are not yet available in WEB-based manual.

4. At the University Park Campus, fire hydrant flow for existing hydrants may be available from Engineering Services.

D. Backflow Prevention

1. No water service connection shall be installed or maintained to or at any building where actual or potential cross-connections to the system would result, unless such actual or potential cross-connections are abated or controlled to the satisfaction of Engineering Services.

2. No connection shall be installed or maintained whereby water from an auxiliary water supply may enter the University water system unless such auxiliary water supply and the method of connection and use of such supply shall have been approved by Engineering Services.

3. An approved backflow prevention device shall be installed prior to the first branch line leading off each service line to a building water system.

4. An approved double check or reduced pressure zone backflow prevention device shall be installed on each service line to a building water system. Type of backflow prevention device shall be determined by Engineering Services. Backflow prevention devices shall be installed at a location and in a manner approved by the Engineering Services and shall be installed by a person properly qualified. At University Park, Apollo brand backflow preventers shall be furnished by Utility Services for installation by the contractor on the potable water service. Reduced pressure backflow preventers shall not be located in pits or other areas that can fill with water unless previously approved by Penn State Engineering Services. Backflow prevention devices shall be located on the building side of the water meter, as close to the meter as is reasonably practical and prior to any other connection.

5. An ASSE certified double check valve shall be installed on each fire service. Fire service backflow preventers shall NOT be furnished by Utility Services, regardless of location.

E. Booster Pumps

1. Where a booster pump has been installed on the service line to or within any building, such pump shall be equipped with a low pressure cut-off device designed to shut off the booster pump when the pressure in the service line on the suction side of the pump drops to ten pounds per square inch gage or less for a period of 30 seconds or longer.

F. Operation and Connection to Existing Waterlines

1. The operation of all existing water valves and hydrants shall be done only by University water system operators. The Contractor and any other personnel are expressly forbidden from operating the water system components.

2. At University Park, all connections to existing waterlines shall be done by the University. These connections shall be done as follows: The Contractor shall provide all required fittings, excavate a pit of sufficient size to install the tapping machine, provide equipment to place and remove the tapping machine, backfill the excavation after the tap is made, restore the surface area, and pay the University a fee for the tap. The fee shall be as determined by the Manager, Utility Services. The University will provide the tapping machine and perform the tapping of the existing waterline.

3. At all Penn State locations other than University Park, connections to existing waterlines shall be done by the contractor, but only in the presence of PSU Office of Physical Plant staff.

G. Temporary Water Service

1. Temporary service is defined as a water service provided for events, food vending, construction, or maintenance supplied from a building or hydrant using temporary piping for 30 days or less. Nonpermanent service (greater than 30 days) will be addressed by the Office of Physical Plant, Water Systems, on a case-by-case basis.

2. The Pennsylvania State University, Office of Water Systems, will provide customer hook-up to an existing building source such as hose bibbs, including a backflow preventer, and water meter.

3. The University will ensure proper disinfection by sampling at the existing hose bibb for chlorine residual and coliform bacteria prior to customer use of the water.

4. It is the customer's responsibility to ensure that proper disinfection continues from the existing hose bibb to their equipment and to the consumer. The University will provide a procedure with recommendations to the customer to ensure proper disinfection. (See Fact Sheet.)

5. The temporary tap and sampling costs will be the responsibility of the customer.

33 20 00 WELLS

A. At University Park, the University supplies the University Park Campus, the Research Park, and Mount Nittany hospital drinking water from deep wells located on PSU property near campus. These wells produce very high quality water at pumping rates from 200gpm to 1200 gpm per well. The University considers these wells a valuable resource that must be protected. In addition, the University Park water withdrawal is regulated by the Susquehanna River Basin Commission and its rules and regulations. All well drilling activity shall comply with SRBC regulations.

B. In keeping with its focus on environmental stewardship, the University considers groundwater a valuable resource that must be protected at all locations, not just those where groundwater is used for potable water services.

C. Any project that is considering geothermal, production, test or monitoring wells shall meet the following:

   1. The Project shall retain the University’s registered geologist during the early planning phase to determine the feasibility of installing geothermal wells, and set preliminary limitations on wells drilled within the project area.

   2. If geo-thermal wells are feasible, the Project can retain another registered geologist to provide a Drilling Plan.

   3. No drilling shall be done before this Plan is approved by Engineering Services.

   4. All drilling shall be under the direction of a registered professional geologist.

   5. The Plan shall include but not limited to the following as a minimum:

a. Details of the exploratory and finished wells.

1) Number proposed

2) Proposed location

3) Proposed depth

4) Proposed construction: The Plan must address how the drilling contractor will deal with conditions such as lost circulation during drilling and loss of grout during the grouting operation.

5) Material used in the construction and chemical composition of all material used in the well.

b. Name and contact information for the drilling contractor.

c. Proposed dates of drilling.

d. Name and contact information of the geologist representative that will be on site during drilling.

e. All open drill holes shall be equipped with a locking cap.

f. Abandonment Plan for test wells in the event geothermal wells are deemed to be infeasible.

2. Upon completion of the drilling, drilling logs for each well shall be provided to Engineering Services. Electronic copies are encouraged. The drilling log shall include the following: description of geologic material encountered (limestone, dolomite, etc.), depth to competent bedrock, static water level, depth and flow rate of water bearing zones, depth interval of voids or significant fracture zones, depth interval and diameter of boreholes, casings (both inside and outside).

3. If an exploratory/test well is completed, the results shall be provided to Engineering Services along with any changes to the approved Drilling Plan resulting from data collected from the test well.

33 30 00 SANITARY SEWERAGE UTILITIES

.01 Sanitary Systems

A. Collection Systems

1. Provide manhole at change of directions. Note: See Manhole Details 15G-A and 15G-B. Details are not yet available in WEB-based manual.

2. Sanitary sewer lines shall be either PVC, vitrified clay, or ductile iron. All pipe shall have a premium watertight joint.

3. Minimum size storm and sanitary lines shall be six (6) inch.

4. All storm and sanitary lines shall be a minimum of 4 feet below grade and backfilled on the bottom and sides of the pipe to a height of one foot above the top of the pipe with PennDOT 2A Stone. The remaining backfill material shall be earth, free of wood, ashes and other debris, but may contain rock pieces not larger than one cubic foot in volume, but consisting of not more than twenty-five percent rock by volume. No other material shall be used as backfill.

5. All sanitary manholes shall be tested to establish no infiltration using either a hydraulic or pneumatic test. All sanitary sewer lines shall be tested to establish no infiltration using a low pressure air test. Coordinate with Engineering Services.

6. Provide clean-outs on building sanitary sewer laterals at changes in direction and at maximum intervals of 150 feet.

B. House Traps

1. House traps are not required unless a specific request is made by the codes official.

C. Manholes

1. Sanitary Manholes.

a. Manholes shall be provided at changes in direction.

b. Manholes shall be fitted with non-locking type or locking type (as required by service and indicated on drawings) heavy frame and cover. The type of service shall be cast in each cover in three (3) inch high letters.

c. Provide manholes with cast-in-place rungs made of aluminum conforming to ASTM B221, alloy 6061T-6. Coat the embedded ends of aluminum rungs with two coats of bituminous paint. Space rungs 12" center to center. Steps shall be 12" wide with five (5) inch projection from the wall and 4 1/2" projection into the wall.

d. Manholes shall be reinforced precast concrete and conform to ASTM C-478. Provide suitable rubber gasketed joints which meet ASTM C443 between sections. Manhole bases shall be cast-in-place concrete. The top section of the manhole shall be of the eccentric cover type so that manhole steps form a straight ladder, for manholes 5'-0" and deeper. Openings required that are not cast in the manholes must be machine core bored.

e. Provide invert channels of cast-in-place 3500 psi concrete. The channel shall be smooth and accurately shaped to conform to the inside surfaces of the incoming and outgoing pipes.

f. Provide outside drop connections where the difference between the inflow and outflow elevation exceeds 2'0". Encase the drop pipe and fittings in 3,500 psi concrete.

g. Joining of pipes to manholes shall be made thru rubber gaskets cast integrally in the manhole wall and located as required. Joints shall meet the requirements of ASTM C443 and ASTM C425.

h. Refer to Details 15G-A and 15G-B (15G changed to Division 33). Details are not yet available in WEB-based manual.

D. Oil/Water Separators

1. Oil/water separators shall be used wherever mandated by Federal, State, local, or University criteria. Under no circumstance shall any oil/water separator be installed without being reviewed by Engineering Services.

2. The use of enzymes or chemicals shall not be permitted without the approval of the required regulatory authority.

3. Oil/water separators shall discharge to the sanitary sewer.

4. Operations and Maintenance (O&M) manual shall be provided to the University for any Oil/water separator. The O&M manual will also include design assumptions used, sizing computations, and recommended cleaning schedule.

5. Refer to section 15G.12.

33 40 00 STORM DRAINAGE UTILITIES

.01 Stormwater Systems

A. Stormwater Management

1. All projects shall include a stormwater management plan that conforms to the most recent local stormwater management ordinance. Projects at University Park located within the Fox Hollow Drainage Basin shall conform to the Fox Hollow Drainage Basin Stormwater Management Design Manual <www.opp.psu.edu/stnd/stnd.htm#design_standards>.

2. Recommended Practices

The University promotes foremost the use of conservation design practices that preserve and use natural critical hydrologic areas, including, but not limited to, floodplains, wetlands, streams, minor drainageways, natural recharge areas, carbonate closed depressions and sinkholes. It also promotes the use and application of sound science in our stormwater management practices and does not believe that any BMP or Low Impact Development (LID) method can be used anywhere, or that we can engineer replacements to complex natural hydrologic areas. Therefore, site designers shall make every effort to preserve these areas, and any disturbance is only permitted at the approval of OPP Engineering Services.

Adequate treatment must be accomplished prior to stormwater runoff being injected into an engineered infiltration BMP or areas where infiltrated runoff can rapidly bypass the soils and enter fractures or the groundwater. Water quality pretreatment facilities must be visible and accessible to provide a means to monitor their efficiency, and replace if necessary in case of failure. Every effort should be made to insure that the quality of stormwater that is to be artificially recharged is of equal or better quality than the existing groundwater. If sinkholes or rapid infiltration does occur, limited water quality impacts may occur if the water is of high quality.

Construction practices must be utilized so as to minimize the compaction of existing soils. In addition, a) soil at grade should be managed and b) vegetative cover and organic amendments should be utilized to enhance the restoration of infiltration capacity of disturbed soils.

As a nationally recognized institution of higher learning, the University reserves the right to request comprehensive computations that defends a designs function above and beyond those required for regulatory approval in order to protect health, safety, and welfare.

The University's recommended practices for land development activities at shall be based on a thorough understanding of the watershed, soils, geology, site density, existing conditions, and the local regulatory requirements. Examples of recommended practices are available for the University Park Campus from Engineering Services.

3. Supporting Documentation

All stormwater management final reports and plans shall be provided to Engineering Services. **In addition to the stormwater reports required by a municipality and/or PaDEP, the professional must fill out and submit the Penn State Stormwater Management Facility Summary Sheets** http://www.opp.psu.edu/construction/standards/design_standards/StormwaterSummarySheet.pdf**, and the Penn State Green Roof Summary Sheets,** http://www.opp.psu.edu/construction/standards/design_standards/GreenRoofSummarySheet.pdf**, if applicable.** Final payment can be held until documentation is received.

Digital as-built surveys of all stormwater management facilities, including but not limited to, surface ponds, underground detention facilities, BMPs, and conveyance pipes will be provided to Engineering Services.

All stormwater BMPs need to be properly installed, operated, and maintained. The professional shall provide the University with three (3) copies of all stormwater Operations and Maintenance Manuals. Additionally, the engineer shall fill out the **Penn State Stormwater Operations and Maintenance Summary Sheet,** http://www.opp.psu.edu/construction/standards/design_standards/StormwaterO_MSheet.pdf **for each BMP.**

4. The use of porous (asphalt) pavement is prohibited at University Park Campus. Porous pavement may be used at other campuses at the approval of Engineering Services.

5. The use of structural stormwater best management practices that replace existing subsoils with inert materials or gravel are discouraged unless it can be documented that the remaining soils are stable and can renovate pollutants in the stormwater. Stating general rules of thumb, such as there are 2ft of soil above restricting layers, are not acceptable for documentation.

B. Collection Systems

1. Provide manholes or inlet boxes at all horizontal or vertical changes of direction for storm drain lines.

2. Storm drain lines shall be either corrugated metal pipe, reinforced concrete, or duel walled high density polyethylene. If corrugated metal pipe is used, a minimum gauge of 14 shall be used and the pipe must be coated with bituminous or aluminized. Pipe material used for pipes greater than 24" diameter shall be at the direction of Engineering Services. All pipe shall have watertight joints.

3. Minimum size storm drains conveyance lines shall be fifteen (15) inch, with the exception of underdrains, BMP distribution systems, properly sized roof leaders, or where the lines tie into a smaller existing downstream storm drain, which shall have a minimum size of six (6) inches.

4. The minimum pipe slope for new storm drains shall be 0.5% (0.005ft/ft).

5. The crowns of all storm drain lines shall be a minimum of 2 feet below grade and meet manufactures depth recommendations. Pipes to be backfilled on the bottom and sides of the pipe to a height of one foot above the top of the pipe with PennDOT 2A stone. The remaining backfill material shall be earth, free of wood, ashes and other debris, but may contain rock pieces not larger than one cubic foot in volume, but consisting of not more than twenty-five percent rock by volume. No other material shall be used as backfill.

6. Inlet boxes and appurtenances shall conform to Pennsylvania Department of Transportation

Standards for Roadway Construction (RC), and Publication 408 specifications. All yard drains, including those in landscaped areas, shall be concrete with minimum interior dimensions of 12" x 12" and shall be H20 load rated. Yard drains located in landscaped areas with material other than concrete shall be used only when approved by Engineering Services.

7. All storm drain structures including manholes and inlets deeper than five (5) ft shall have access steps per the PennDOT Roadway Construction standards.

8. Some storm drains may require exfiltration testing where there are sinkholes. Coordinate with Engineering Services.

9. Provide clean-outs on all roof bends and at the end of BMP underdrains at a minimum.

10. The maximum spacing between storm drain manholes or inlets shall be 300 ft.

11. Inlet spacing on new roadways in curbed sections will be based on an allowable spread of ½ the travel lane or a maximum of 6'.

12. All storm drain inlet grates located in travel areas or lawns to be PennDOT bicycle safe.

13. All storm pipe or culvert outlets must have stable erosion resistant energy dissipaters. Where hydraulically possible, outlets should use sumped pre-formed scour holes.

14. Any new storm culvert or pipe outlet must have a concrete endwall or endsection.

15. All storm drain hydraulic computations must be done in accordance with the Federal Highway Administration's Urban Drainage Design Manual, Hydraulic Engineering Circular No. 22 (HEC-22). Hydraulic grade lines for all new storm drain lines must be provide to Engineering Services on request.

16. All new storm drains shall be designed to pass the 10-year event discharge without surcharging. Surcharging is defined as the maximum permissible water surface elevation in a manhole or inlet one (1) ft below the top of grate elevation.

17. Vegetated stable open channels shall be used whenever possible. All channels greater than or equal to 10% slope shall be designed by shear stress methods.

18. Specialized water quality inlet boxes shall not be installed without the direction and approval of Engineering Services. Under no circumstance are systems that use replaceable filters or cartridges to be used.

19. All manholes and inlet boxes shall have a smooth flow line channel formed of cast-in-place 3500 psi concrete for all storm drains 24 inch or larger. The channel shall be smooth and accurately shaped to conform to the inside surfaces of the incoming and outgoing pipes.

20. Under certain conditions, Engineering Services may request manhole covers be placed on inlet boxes. See 15G11.C1.

21. All subsurface detention facilities are to have access/clean out points located on each end of the facility.

22. Sumped inlets on roads or other critical areas must have flanking inlets in the event of clogging.

23. Under no circumstances shall surface water be directed towards a building. All designs shall include gravity flow away from buildings in the event that inlets are clogged.

24. The layout and design of all subsurface detention facilities shall be reviewed by Engineering Services prior to being submitted to outside review agencies.

25. Ductile iron pipe shall be used for storm drains wherever storm drains cross steam lines closer than 3’-0”.

26. Reinforced concrete pipe shall be used for all pipes crossing roadways.

C. Manholes

1. Storm Manholes.

a. Manholes shall be provided per section 15G11.B.1.

b. Manholes shall be fitted with 30” diameter non-locking type or locking type (as required by service and indicated on drawings) heavy frame and cover. The word “STORM” shall be cast in each cover in three (3) inch high letters.

c. Provide manholes with cast-in-place rungs made of aluminum conforming to ASTM B221, alloy 6061T-6. Coat the embedded ends of aluminum rungs with two coats of bituminous paint. Space rungs 12" center to center. Steps shall be 12" wide with five (5) inch projection from the wall and 4 1/2" projection into the wall.

d. Manholes shall be reinforced precast concrete and conform to ASTM C-478. Provide suitable rubber gasketed joints which meet ASTM C443 between sections. Manhole bases shall be cast-in-place concrete. The top section of the manhole shall be of the eccentric cover type so that manhole steps form a straight ladder, for manholes 5'-0" and deeper. Openings required that are not cast in the manholes must be machine core bored.

e. All other manholes criteria shall conform to Pennsylvania Department of Transportation Standards for Roadway Construction (RC), and Publication 408 specifications.

D. Oil/Water Separators

1. Oil/water separators shall not be used for stormwater management systems except at the direction of Engineering Services. Refer to sections 15G.10.C and 15G.12 if required.

33 50 00 FUEL DISTRIBUTION UTILITIES

.01 Gas

A. Characteristics

1. University owned gas piping network on University Park Campus is carried at 5 psi. Gas is natural with heating value at 1030 btu/cu. ft. Parts of the system owned by Columbia Gas of Pennsylvania will be carried at 35-50 psi.

At all locations consult with Utility Systems Engineering for gas system ownership and procedures to be followed.

B. Distribution Systems

1. Piping

a. All materials used in the gas line installation and the construction methods at

University Park Campus shall be in according with the International Fuel Gas Code, and as approved by Columbia Gas of Pennsylvania, Incorporated or, at other locations, in accordance with regulations of the local gas company.

b. Furnish a gas pressure regulator and meter with a bypass in accordance with the International Fuel Gas Code, and as approved by Columbia Gas of Pennsylvania, Incorporated. This regulator shall be installed external to the building and supported in a manner having the approval of the Columbia Gas of Pennsylvania, Incorporated, or the local gas company at other locations.

c. Gas piping at the University Park Campus shall be Schedule 40, black, with corrosion-resistant material, conforming to ASTM, A53. Joints in buried piping shall be welded. Joints above ground shall be screwed with malleable fittings for piping two (2) inches and smaller (unless otherwise required by the gas company) and welded for piping two and a half (2 1/2) inches and larger.

All welding shall be performed by a certified welder.

Welded fittings shall conform to ASTM A234 and screwed fittings shall be 150 pound black malleable. All pipe and joints shall be coated for corrosion protection with plastic material similar to pipe covering.

Consult with Engineering Services for standards to be used at other locations.

d. Gas piping shall not be carried through manholes. Where a branch line is taken from a gas main located in a tunnel, a valve and curb box shall be located outside the tunnel.

e. At low points on horizontal piping and at the foot of each riser and each drop, a full-size drip pocket six (6) inches long, shall be installed.

f. All underground lines shall be protected from corrosion by the installation of magnesium anodes as required. Install test stations at adjacent buildings or in the ground with concrete aprons.

C. System Tests

1. All gas lines installed shall be tested in accordance with the International Fuel Gas Code.

33 56 00 Fuel-Storage Tanks

.01 Underground/Aboveground Storage Tank Design

A. EHS shall be contacted to provide guidance in the planning and design of facilities that include any new aboveground or underground storage tanks or modification/replacements of any existing tanks. This includes tanks that are used for petroleum products and other oils as well as those used for other hazardous materials (i.e., caustic soda). Site-specific requirements will be provided by EHS.

B. All new fuel storage tanks shall be aboveground, unless specifically reviewed and approved by EHS.

C. All new tanks shall have a Spill Prevention, Control, and Countermeasures (SPCC)Plan or a Preparedness, Prevention and Contingency (PPC) Plan prepared under the direction of EHS.

D. Provide a copy of equipment, materials and installation details submittals to EHS in timely manner for review prior to installation.

E. All tank installations shall provide complete startup and training services coordinated and scheduled well in advance with Owner’s representative(s) to attend. Obtain certification that startup and training was completed with Owner’s representative signature(s) and submit completed certification of training to Project Manager.

.02 Aboveground Storage Tanks

A. Provide aboveground storage tank installations in accordance with current EPA, DEP, Department of Labor and Industry Flammable and Combustible Liquids Section (or Philadelphia or Allegheny County, where they take precedence), township/borough requirements (where applicable), NFPA, and EHS requirements.

B. Contractor shall be required to provide the University with necessary Department of Labor and Industry Fire Safety Permit and DEP Storage Tank Registration, where applicable.

C. All new aboveground stage tanks shall meet the appropriate UL standard.

D. Tanks shall be set on a concrete pad to prevent the settling of the tank. The pad shall be in accordance with the tank manufacturer's recommendations.

E. All aboveground storage tanks shall have secondary containment, fill drop tube, spill prevention, overfill prevention, and mechanical leak detection (electronic monitoring/alarming not required).

F. Any work on DEP regulated aboveground storage tanks shall be performed by DEP certified tank installer/inspector.

G. "No Smoking" and "Stop Motor" signs shall be posted in all fuel dispensing areas, and a "No Smoking" sign shall be displayed on the tank. Fuel pumps and aboveground storage tanks shall be protected from vehicles with bollards. If the tank is to be located in a trafficked area, bollards shall be installed around the tank.

1. Bollards shall be 6" diameter standard strength steel pipes filled with concrete, with rust inhibiting coating on entire exterior surface. Bollards shall be securely at least 3 feet into the ground, 4 feet high, 4 feet apart, set at least 2 feet from the shell of the tank. If the tank is located in a grassed area away from travel lanes, bollards shall not be required.

H. Contents of the tank shall be identified on the tank exterior, and all ports, vents, etc. shall be labeled.

I. Piping (single wall) shall be run completely exposed to allow for complete visual inspection. Otherwise if piping must be enclosed, it shall be double-wall with interstitial piping space draining back to a sump monitored by an automatic leak detection system.

.03 Underground Storage Tanks

A. Provide underground storage tank installations in accordance with current EPA, DEP, Department of Labor and Industry Flammable and Combustible Liquids Section (or Philadelphia or Allegheny County, where they take precedence), township/borough requirements (where applicable), NFPA, and EHS requirements.

B. Contractor shall be required to provide the University with necessary Department of Labor and Industry Fire Safety Permit and DEP Storage Tank Registration, where applicable.

C. All new underground storage tanks shall meet the appropriate UL standard.

D. All underground storage tanks shall have secondary containment, fill drop tube, spill prevention, overfill prevention, and automatic electronic leak detection. Provide audible and visual alarms annunciated in a normally occupied space.

E. All work on DEP regulated underground storage tanks shall be performed by DEP certified tank installer/inspector.

F. “No Smoking” and “Stop Motor” signs shall be posted in all fuel dispensing areas, and a “No Smoking” sign shall be displayed on the tank. Fuel dispensers and pumps shall be protected from vehicles with bollards.

1. Bollards shall be 6” diameter standard strength steel pipes filled with concrete, with rust inhibiting coating on entire exterior surface. Bollards shall be securely at least 3 feet into the ground, 4 feet high, 4 feet apart, set at least 2 feet from the fuel dispenser or pump.

G. Contents of the tank shall be identified on the tank fill pipe and all ports, vents, etc. shall be labeled.

H. Piping shall be double-walled suction piping. Interstitial space shall drain to a sump monitored by the automatic leak detection system. Piping shall not be under positive pressure.

33 60 00 HYDRONIC AND STEAM ENERGY UTILITIES

33 61 00 Hydronic Energy Distribution

33 63 00 Steam Energy Distribution

.01 Steam

A. Characteristics at University Park Campus

1. Low pressure steam (where available) 10-12 psi summer, 5-12 psi winter; design for 5 psi.

2. High pressure steam (where available) 150 psi. Pressures may fluctuate to a low of 90 psig in winter.

B. Characteristics at other locations

1. For characteristics at other locations, discuss with Engineering Services.

C. Distribution Systems

1. Steam Mains

a. Use concrete trench design for steam, condensate, and compressed air. For details, contact Engineering Services. Any other types of underground piping systems must be discussed with Engineering Services.

b. Expansion shall be taken up with expansion joints in manholes. Expansion joints shall be Advanced Thermal Systems Type TP2, no substitutions. Underground offsets and loops will be permitted on a case by case basis. Design piping expansion for 250 psi.

c. Ball joints are not normally used. Where they must be used, because of field requirements, use the injectable packing type. Advanced Thermal Systems Series "P2" ball joint shall be used with no substitutions.

d. Drip stations shall be provided at all low points and every 150'-200' of run. Refer to Division 15B.17 for arrangement of drip station.

e. Steam manholes require specific discussions with Engineering Services.

2. Steam Meters

a. Steam meters shall be selected and sized by Engineering Services. The professional shall provide building steam load to Engineering Services for steam meter sizing.

b. Steam meters shall be provided and installed by Utility Services. Contractor shall install orifice flanges supplied by Utility Services. Location of orifice flanges shall be specified by Engineering Services. Utility Services shall install the meter transmitter. Contractor shall provide and connect power to the transmitter from the building BAS system.

c. The Professional shall provide for and indicate an adequate straight run of pipe on drawings for an orifice meter installation.

3. Condensate Pumps

a. Condensate pumps shall be duplex, not to exceed 1,800 rpm, with alternator; both pumps to come on at high level. Discuss discharge head with the University. Install check valves to prevent circulation through inactive pump. See Detail 15G-C for piping at meter and condensate return pumps.

Discharge shall have a ball or plug valve with memory stop to provide for pump discharge pressure adjustment.

b. Consideration shall be given to using Pressure Powered condensate pumps by Spirax/Sarco or equal, where economically justified. Pumps shall use air for pumping where possible.

c. See Detail 15G-D for piping connections at pressure powered condensate pumps. Details are not yet available in WEB-based manual.

d. All steam fittings shall be ANSI Class 150 for low pressure steam and ANSI Class 300 for high pressure steam.

4. Steam, Condensate, and Compressed Air Valves

a. Steam valves shall be steel laminated seat zero leakage triple offset butterfly valves. All valves to have gear operators. Steam valves shall be ANSI Class 150 for low pressure steam and ANSI Class 300 for high pressure steam. Valves material and construction shall be approved by Engineering Services. Cast iron valves shall <u>not</u> be used. Acceptable manufacturers are Adams, Tricentric, Zwick and Vanessa.

b. Condensate valves 2 inch and smaller shall be stainless steel ball valves; e.g., Apollo. Larger valves shall be high performance butterfly valves; e.g., Jamesbury or Keystone. Valves material and construction shall be approved by Engineering Services. Cast iron valves shall <u>not</u> be used.

c. Compressed air valves shall be stainless steel ball valves.

D. Tests of Steam Distribution Piping

New steam distribution piping systems which connect to existing hot steam lines shall be tested as follows:

1. The new system shall be installed and the ends of the lines blanked off prior to making the connection to the existing hot line.

2. The line shall then be hydrostatically tested as specified and thoroughly flushed out.

3. Make final connections to existing hot lines, energize, and waste condensate.

4. De-energize and open and clean all dirt legs and strainers.

   (The purpose of this test is twofold: (1) To stress line under expanded conditions prior to hydro test; and (2) To knock off and then flush out as much mill scale and debris as possible.)

.02 Air

A. Characteristics

1. Line pressure 60-80 pounds. This is central plant air and is available on most of the University Park Campus. Provide proper dryer and separator tanks with automatic blowdown piped to nearest drain, and provide refrigerated air dryer with automatic blowdown piped to nearest drain.

2. Oil removal equipment must be provided in the building.

3. Central air is not available at other locations.

B. Distribution Systems

1. Underground compressed air piping shall be fiberglass reinforced plastic (Fibercast, Centricast Plus RB-2530). Where piping passes through manholes, convert to steel with flanges.

2. Piping shall have a trap, with a half-inch ss ball valve and an automatic drain located at the low point where the piping enters the building. In addition, half-inch ss ball valves with brass plugs shall be provided at all low points to bleed entrapped moisture. Provide oil filters in the lines as needed.

3. All underground fiberglass piping shall have a twelve gauge stranded copper tracer wire attached to the top of the pipe.

C. System Tests

1. All air lines shall be tested at 100 psi air pressure for a period of four (4) hours using test connections and testing equipment furnished by the Contractor. The only permissible drop in pressure shall be that due to temperature drop.

33 70 00 ELECTRICAL UTILITIES

.01 Electric (See Division 26)

33 80 00 COMMUNICATIONS UTILITIES

.01 CCS

Refer to Division 23 09 00 and 25 00 00 (Reserved for future use).

.02 Telecommunications

See Division 27.