### Design Guidelines

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Foreword

Advice to Architects and Engineers

Your team has been chosen as the architectural/engineering team most uniquely qualified to design the project, based upon your ability to effectively communicate and demonstrate to the selection committee your team’s design expertise, your understanding of the project, and your commitment to service. In order for your team to successfully exercise the highest degree of design potential afforded by the project, we offer you a few words of advice in the attainment of that goal.

1. Ask Questions

Although your team was chosen as best suited to the project, this may be the first project of this particular building type you have undertaken at ASU. ASU’s design philosophy does not allow a “cookie cutter” approach to design, hence, there will be many unknowns to your team on this Campus. Time spent in researching the goals ASU had in mind when preparing the RFQ, familiarity with campus infrastructures, how and why design was handled in a particular way on a similar project, and familiarity with the university and user group structure prior to the beginning of architectural programming, will be invaluable to your design team. The Project Manager/Project Architect assigned the responsibility to lead this project on behalf of ASU is your single best resource for the project. All questions and communications regarding the project, the user group or the university must be routed through these individuals. This is the established project protocol, and will be further detailed to you by those individuals. It is their responsibility to answer, or direct you to those that can answer specific questions regarding any topic connected with the project in a timely and professional manner.

2. Time is Money

A common comment we hear from design professionals is that the project budgets, schedules and professional fee structure precludes firms from devoting the proper amount of time toward design excellence. ASU realizes that design is a time-driven undertaking, and we believe this comment can be directly attributed to poor project communications, which wastes time, money and opportunity. The project budget, schedule and your compensation will allow for both a successful design and a successful business partnership provided the following items are observed:

- Strictly observe procedures for approvals. Under no circumstance should verbal approval be accepted or given. Any inquiry or direction that potentially affects project scope, budget, schedule or your compensation should be made in writing and responded to in kind.

- Assume nothing. Assumptions made by your team without written clarification in the form of letters, meeting minutes, sketches or written telephone conference logs will promote misdirection, miscommunications, design errors and subsequently lost time. It is your responsibility to ask for and receive clarification. The worst possible assumption your team can make is assuming that a user will instantly or instinctively understand graphic or technical aspects of design without a thorough
and concise explanation. Photographs and quick three-dimensional color sketches are invaluable tools to achieve this understanding.

- Breach of the project protocol is the best way for your team to lose time and money. Direction, approvals, clarification, etc., that do not originate or go through the assigned Project Manager/Project Architect, no matter what the level or area, are not acceptable and non-binding.

3. Contingencies

Many architects are under the impression that project contingencies (design, construction and inflation) are for the use of design “extras.” This is an erroneous and dangerous impression. ASU is mandated by the Arizona Board of Regents to carry contingencies based on level of functional and construction difficulty and total project duration. Contingencies shall only be utilized to attain the projects critical functional and quality parameters, or “base” scope, as defined by the architectural program and subsequent schematic design.

4. Expectations

The design team is required to be within the particular design phase budget, and if the project estimate at the completion of a particular phase indicates the design is over budget, the team will not gain the approval necessary to enter into the next phase. The team will then be required to expend the necessary time and effort to be within that budget, at the design team’s expense.

It is easy to recognize that the further over budget the design is, the more time and effort will be required to bring the project within the budget. This is time that will not be compensated. It is therefore in the best interest of the design team to obtain the highest degree of detail appropriate to all phases of design, to recognize all cost ramifications to a particular design intent, and avoid promotion and pursuit of design elements that can neither be justified by the program nor afforded by the particular phase budget.

It is the university's expectation that by following the guidelines, procedures and advice as presented in this manual, the design team will produce a facility that not only meets program, budget and schedule, but also achieves a quality of design excellence.
Introduction

The Purpose of This Manual

These Design Guidelines cover ASU construction projects managed by the Capital Programs Management Group. Therefore, the consultants are advised to refer to those sections of the manual that relate to their projects and to adhere to its guidelines.

VARIANCES TO THE GUIDELINES

The Design Guidelines are a set of minimum requirements for design and construction at ASU. Contractors and consultants must adhere to the Guidelines in all cases, unless a written variance is obtained from ASU. Variances to the Guidelines must be submitted to an ASU project manager, in writing. Project managers must then obtain written approval for the variance from Capital Programs Management Group management, and with recommendation from ASU Shops, if necessary. Variances from the Guidelines are not valid unless written approval from CPMG management is received.

Updates

This manual will be updated as requirements and procedures of ASU and the Arizona Board of Regents (ABOR) change.
ASU Office of the University Architect

The ASU Office of the University Architect (OUA) works with the ASU administration, User Group, Project Manager, Design Professional, and Construction Manager from project initiation through project programming. OUA reviews the DP's work for compliance with: planning, programming, exterior and scope requirements for the project; and for conformance to required codes and ASU master plans and procedures.

Responsibilities of OUA include, but are not limited to, the following:

1. Strategic direction for University Architecture and Design
2. Architectural oversight during project development
3. Public Arts and Design Review Council
4. CADD Services
5. Classroom Furniture and Services
6. Space data management, reporting and planning
7. Programming, planning and design services to ASU units and ASU administration
8. Land use, development and campus master plans
9. Development of the capital program.
ASU Capital Programs Management Group

ASU PROJECT MANAGER (PM)

The Project Manager, or PM, guides each project from programming through project close out and warranty. The PM works with the User Group and CMAR to review the DP’s work for compliance with program requirements, schedule, budget, and for conformance to required codes and ASU standards and procedures.

The PM is the direct contact person for the DP, CM, and other project consultants once the project has completed programming. After project programming is complete, all project work, information and correspondence is to be directed to the PM. The PM is the liaison for the user group as well as all other ASU departments. The PM is also responsible for monitoring project activities during design and construction through occupancy.

The responsibilities of the PM include, but are not limited to, the following:

1. Manages the DP and CMAR selection process.
2. Insures the appropriate development and conformance of the project to the program, budget, schedule, and ASU standards.
3. Manages all meetings between the ASU User Groups, DP and CMAR after project programming.
4. Recommends approval of all payments to DP and CMAR.
5. Evaluates DP and CMAR performance for preconstruction, in conjunction with ASU Purchasing.
6. In conjunction with ASU Purchasing, manages the negotiation for a GMP.
7. In conjunction with ASU Purchasing, develops the contract for construction (Design/Bid/Build, CMAR, JOC).
8. Manages all construction administration.
9. Manages the construction contract.
10. Manages project close-out.
12. Manages warranty issues.
ASU User Groups

The ASU User Group (User Group or User) are those colleges, organizations or departments that will be the actual occupants or the direct beneficiaries of the project. User groups can be comprised of several colleges, organizations or departments or a single uniform group. For every project, a User Chairperson will be appointed in order to convey consensus opinions, concerns, comments or information to the design team.

Appropriate sign-off of the DP’s drawings and specifications by the User Chair will be required at each major design phase submittal.

The User group acts in an advisory and informational capacity to the project design team regarding programming/design function and space parameters. These parameters, and the resulting response by the DP to them, will only be discussed at the regularly scheduled BC meetings or will be conveyed by the User Chair to the DP through the PM or OUA representative.
ASU Facilities Management

Facilities Management (FM) is responsible for all ASU physical facility maintenance and operational activity, and therefore has a vested interest in the maintainability and long term operational cost of every physical addition to ASU campuses. The PM attends all scheduled project meetings in both the design and construction phases, and may elect to include other FM personnel as their experience and technical expertise is required.

For all significant construction projects, a Facilities Management project representative will be required by the project manager to participate as a construction team member.

The FM project representative acts in an advisory capacity to the project, and will convey any necessary project issues or information needing resolution to the PM in the design phases and construction phase, for incorporation by the DP.

The responsibility of this individual includes, but is not limited to the following:

1. Obtains information regarding ASU infrastructure, maintenance and operation.

2. Advise on the serviceability, maintenance and quality aspects of all project components and systems.

3. Keeps FM shops and Administration informed of all project activity, issues and progress.

4. Routing of all project document submittals to the applicable FM shops for review and comment.

5. Informing and scheduling FM shops to attend meetings or reviews as necessary.

6. Attends all regularly scheduled project design and construction team meetings.
Other Governing Entities

Depending on the scope, nature and location of the project, the following additional advisory groups may be included as members of the Project Team or will review and approve the design phase documents.

A. ASU POLICE DEPARTMENT

The responsibility of this department is to review the project for life safety, security and fire conflicts or inconsistencies with adopted codes, standards and ASU practices. All designs must be reviewed and commented on by ASU PD; however, this department should not be viewed nor does it function as a code checking entity. If required, this department will advise the DP in regards to life safety, security and fire considerations.

B. ASU PARKING AND TRANSIT SERVICES

This group must be consulted when a project affects any pedestrian and vehicular access, flow, density, direction or parking on campus, either on an interim or permanent basis. This group shall review and sign-off on the site plan and construction staging plan prior to design completion. The DP is responsible for submittals and incorporation of any comments received. If required, this group will advise the DP in regards to campus pedestrian and vehicular circulation and use patterns.

C. ASU DISABILITY RESOURCE CENTER

The Disability Resource Center is an on-campus student organization concerned with accessibility of all structures on campus. A DRC representative is assigned to the project and will review the project for ADA compliance. Sign-off by the DRC representative will be required prior to design phase approval by the Director, FP&C. The DP is responsible for submittals and incorporation of any comments received during design review. During construction phase, communications

D. ASU UNIVERSITY TECHNOLOGY OFFICE DESIGN

Design is a department within the ASU University Technology Office. Their responsibility encompasses all voice and data communication and transmission design for ASU. UTO Design reviews and assists all project design engineering regarding telecommunications and data for conformance with ASU standards (see ASU Telecommunications Standards, provided by PM). Sign-off by UTO Design will be required prior to completion of design. The DP is responsible for submittals and incorporation of any comments received. If required, this group will advise the DP in the design phases regarding ASU telecommunications and data interfacing, serviceability and maintenance.

F. STATE FIRE MARSHALL AND ASU ENVIRONMENTAL HEALTH AND SAFETY

All projects must be submitted by the DP to ASU Environmental Health and Safety (EH&S) prior to review and approval by the State Fire Marshall, at the completion of each design phase. EH&S also reviews plans and projects for fuel burning equipment, lab design for equipment and equipment placement, life safety requirements, and environmental regulatory compliance.
G. STATE ELEVATOR INSPECTOR

Elevator shaftway and equipment contract documents must be submitted by the CMAR to, and written approval received from: Arizona Chief Elevator Inspector, Division of Occupational Safety and Health, Industrial Commission of Arizona, 1624 North Adams Street, Phoenix, Arizona, P.O. Box 19070, Zip 85005; Telephone No. (602)255-3313.

H. STATE OF ARIZONA HISTORIC PRESERVATION OFFICE APPROVALS

Any re-use of, additions to or adaptations of, structures listed on the National Register must be reviewed and approved by this agency.


All facilities for animals kept at the University (with the exception of rodents) are inspected regularly by these agencies. If compliance is not met, these facilities may be closed down or grants or contracts may not be extended.

J. CITY APPROVALS

ASU campuses reside in several cities. The DP must request approval and receive permits for all civil engineering drawings showing grading, drainage, curb cuts, street tie-ins, water and sewer connections, storm water drainage, etc., to the city where the project is located.

K. ASU PERMITTING AND INSPECTIONS

An ASU Building Permit is required for all construction work, including donated construction work, consisting of and not limited to: new construction; demolition; modifications of mechanical, electrical, plumbing and structural systems; fire systems; welding; temporary power connections; manufactured housing installations; and drywell installation, repair and closures.

ASU permitted projects are subject to inspection to monitor compliance with accepted codes and standards, ASU Design Guidelines, contract documents and approved plans.
ASU Construction Parking

Parking at ASU is at a premium. To make the system work for all parking clients, it is necessary to use a system of controls. ASU Parking & Transit Services (PTS) is a self-supporting, service organization dedicated to balancing the competing parking needs of a large and diverse metropolitan university.

Measures specifically dealing with construction are listed below or in the ASU Parking and Vehicle Control Regulations. The following construction parking policies have been implemented in a joint effort between Facilities Management (FM) and PTS on the behalf of Arizona State University.

1. All vehicles, including company vehicles, are required to display valid ASU parking decals/permits.
2. Vehicles parking on ASU property are subject to all ASU Parking and Vehicle Control Regulations.
3. The CPMG Project Coordinator (PC)/Project Manager (PM) will identify and coordinate the staging areas(s) with PTS.
4. Delivery routes to construction sites will be proposed by the PC/PM and sent to PTS for concurrences. Delivery routes will take into consideration: tunnel loads, other CPMG or FM projects, restricted malls, and other ASU and community activity.
5. Deliveries to construction sites will not require a mall permit prior to 7 a.m. nor after 5 p.m.
6. The project area may extend beyond the fenced staging area. PC/PM will coordinate with PTS regarding parking restrictions within the project area.
7. CPMG will assist PTS by enforcing permit requirements inside fenced staging areas.
8. PTS may issue up to 3 permits, depending on need and area available, for the job site to the General Contractor (GC). The permits will list GC firm name, project site and effective dates as a minimum.
9. Contractor employees are required to park OFF SITE in designated parking lots, typically Lot 59. Permits are purchased commodities by the project, contractor or employee. Parking is not free.
10. Questions regarding campus safety issues may need to be coordinated with ASU Environmental Health and Safety.
11. PTS representatives will attend major Pre-Construction meetings to relate parking deal/permit costs/policies reference each construction projects. PC/PM to notify and coordinate with PTS.
12. Permanently lost parking spaces are charged an amount for every vehicle (8’x18) space lost. Disabled access aisles count as one vehicle space lost. Permanently lost motorcycle spaces shall also incur a cost. PC/PM will coordinate cost and payment with PTS.
13. Temporarily lost parking spaces are paid for in accordance with existing PTS policy. PC/PM to coordinate budget with PTS for each project.
14. A Parking Decal can be purchased at the Tempe campus for Lot 59E or Lot 59NE. PTS departments also serve the Downtown, Polytechnic, and West campuses. Contact the appropriate PTS department (online at www.asu.edu/pts) for further information.
15. Mall placards, vendor permits, temporary permits are also available. Contact PTS for more information and costs.

16. The staging area(s) is/are for equipment lay down and to comply with OSHA requirements. Staging area is paid for when located in an existing parking lot or on a mall/pedestrian facility. Contact PTS for costs.

17. Vehicles parked within the staging area must display a valid ASU parking decal/permit. Contact PTS for costs or other information.

18. Reserved stalls and meter stalls can be purchased on a monthly basis. Contact PST for costs.

19. At the Tempe campus, decals/permits/placards may be purchased at the ASU Parking & Transit Services Office located on 5th Street between College Ave. & Forest Ave. between the hours of 7:30 a.m. – 4:30 p.m. Monday – Friday.

20. At the Polytechnic campus: Student Affairs Complex, Quad 2. Hours: Monday – Thursday, 8:00 a.m. - 5:00 p.m.; on Friday, 8:00 a.m. – 4:30 p.m. Phone (480) 727-2775.

21. At the West campus: Parking Lot 12, 4701 W. Thunderbird Rd., Phoenix. Hours: Monday – Friday, 8:00 a.m. – 5:00 p.m. (602) 543-7275.

22. At the Downtown campus: Contact parking at (602) 496-2274. Various parking passes may be purchased at: Downtown Phoenix Campus Cashiering Office, 1st floor of University Center, 411 N. Central, Phoenix. The office is across from the lobby elevators in room 112. Hours: 8:00 a.m. – 5:00 p.m.

23. It is the GC’s responsibility to inform the subcontractors of the parking arrangements on ASU property.

24. All damages to parking lots/equipment will be the responsibility of the project/GC. The PM is required to coordinate all damage repairs with PTS and comply with PTS repair specifications.

All parking rates are subject to change. Additional information can be found at www.asu.edu/pts. If you have any questions, please contact the PM affiliated with your project or Parking and Transit Services at (480) 965-6803.
Appendix 1
ASU Accessibility Standards

Revised October 6, 2009
ASU Accessibility Standards

Italics indicate information quoted from the ADA Accessibility Guidelines for Buildings and Facilities or ADAAG, and is listed for clarity and/or emphasis. Where ADAAG gives a range of sizes or dimensions, the size or dimension for ASU standards is given below.

4.1.1 Application

- All areas of newly designed or newly constructed buildings and facilities required to be accessible by ADAAG 4.1.2 and 4.1.3, and altered portions of existing buildings and facilities required to be accessible by 4.1.6 shall comply with the revised ADAAG guidelines, 4.1. through 4.35.

4.2 Space Allowance and Reach Ranges

- Forward reach and side reach allowances shall be the same dimensions.
  - Maximum height shall be 48”. ASU requirement.
  - These dimensions apply to all operable parts of fixtures and equipment on the wall or elsewhere.
  - Maximum reach heights over a counter or obstacle more than a depth of 20”, please refer to the chart in ADAAG 4.34.3 (b).

4.3 Accessible Routes (including construction and landscape)

- Construction Site
  - Fencing shall enclose all construction areas. Warning tape is not acceptable as the blind and visually impaired are unable to see the tape.
  - Transition strips are required on all temporary ramps during construction.
  - Ramps to sidewalks or buildings shall not be blocked by vehicles or equipment.
- Exterior steps as landscape are not desirable.
- Accessible gathering areas in the landscape plan are desirable.
- Sidewalks shall support aggregate borders on both sides of the walk. These borders are used by the blind and visually impaired to give direction to the malls and buildings.
- Flare sidewalks (a radius edge) where all sidewalks intersect another sidewalk. This prevents wheelchairs from falling off a sidewalk when making a 90 degree turn.
- Decomposed granite shall not be used on pathways. Wheelchairs users find this difficult to travel on and it’s hard to maintain for wheelchair users.
- Blue Light Emergency telephones
  - Maximum 48” height to operable parts of the telephone. If reaching over an obstacle (an example would be a curb) then refer to chart in ADAAG 4.34.3(6).
  - Accessible from front or side (concrete pad 48” X 36” where needed for access).

4.8 Ramps

- Ideal slope on ramp is 1:16 (1 inch rise for each 16 inches of run). ASU requirement.
- Top of handrails at 34” height. ASU requirement.
- Handrail size to be 1 ½” diameter. ASU requirement.

4.9 Stair/Steps

- A textured surface with a contrasting color shall be installed on the top and bottom steps of all staircases and on the floor of all landings. ASU requirement.
• Open risers are not permitted on staircases - ADAAG 4.9.2.
• Height of handrail 34” measured to centerline of handrail. ASU requirement.

4.10 Elevators
• Always more than one per building.
• Automatic elevator doors shall stay open 5 seconds minimum – ASU requirement.
• Phone or intercom panel may be located below control panel, or at side no higher than 48” ht.
• Emergency phone must be 2-way intercom.

4.13 Doors
• Signage shall be provided at inaccessible doors indicating where nearest accessible door is located.
• Automatic Door Openers on all accessible entrances shall comply with ADAAG 4.13.12.
• Door hardware - ADAAG 4.13.9.
  • Closer force at exterior doors shall be 8 lbs. maximum where Automatic door closer is not required – ASU requirement.
  • Closer force at interior doors shall be 5 lbs. Maximum – ADAAG 4.13.11.
• A texture shall be installed on all push bar hardware at all fire exit doors.
• All interior doors to be accessible (36” wide door is required with lever hardware) – ASU requirement.

4.13.12 Automatic Door Openers – ASU requirements
• Automatic Door Openers are required on all accessible exterior entry doors, restrooms, unisex restrooms, accessible dorm rooms and classrooms/labs with exterior entrances.
• Push pad 4 ½” square or round brushed stainless steel push pad 6 ¼” diameter (example of a manufacturer would be Horton.)
• Height of door opener pads is 32” on center.
• Location of opener pads determined by ASU – not the architect. Locate push pad 24” from latch side of door if space permits.
• Push pads for exterior doors are battery operated.
• Push pads for restrooms are hard-wired.
• Electric Strikes where needed.
• Mag-locks are required on Unisex restrooms.
• Maintain a minimum of 8” clearance above the door frame for opener housing.
• Door opener housing must be inside the room.
• Outlet for opener housing installed on latch side of door.

4.15 Drinking Fountains
• Locate close to restrooms if possible.
• Projection of the water fountain into the path of travel should be 4” maximum in the fountain is 27” a.f.f. Drinking fountains in a corridor should be set in an alcove, or screened to prevent a blind person from walking into it.

4.16 Accessible Water Closets
• Distance from centerline of toilet to nearest wall to be 18” exactly – ADAAG 4.16.2 figure 28.
• 60” of clear space required around the toilet so a wheelchair can pull up next to toilet for a transfer – ASU requirement.
• Toilet seat 18” - 19” height. ASU prefers 19”.
• ASU typically does not use toilet seat cover dispensers.
• Automatic toilet flush (example of a manufacturer would be AutoFlush by Technical Concepts - stock #401187) – ASU requirement.
• If flush valve used it shall be mounted on wide side of toilet – ADAAG 4.16.5.

4.17 Accessible Toilet Stalls
• Where 6 or more stalls are provided, including the accessible stall and urinal stalls, at least one stall must be an Ambulatory stall – ADAAG A4.23.4.
  • Ambulatory stall should be adjacent to wheelchair stall – ASU requirement.
  • Coat hook on door of accessible stalls at 48” height – ASU requirement.
  • Sliding latch on accessible stalls shall slide easily using only a fist – ASU requirement.
  • Pull handles shall be installed on BOTH sides of accessible stall doors at 36” height, near the latch.

4.17.6 Grab Bars
• Size 1 ½” diameter at 36” height – ASU requirement.

4.18 Accessible Urinals
• Automatic urinal flush (example of a manufacturer would be AutoFlush by Technical Concepts – stock #401186) – ASU requirement.

4.19 Accessible Lavatories
• Automatic faucet (Example of a manufacturer would be SmartSensor/ThermoSensor) at lavatory in Unisex restroom and at one (1) accessible sink in each public restroom – ASU requirement.
• Operable part of soap dispenser at 42” height if over a counter or sink – ASU requirement.
• Operable part of paper towel dispenser is 48” height – ASU requirement.

4.23 Bath Rooms and Shower Rooms
• Shower Rooms
  • Shower stalls are not allowed in Unisex restrooms – ASU requirement because of liability.
  • All departmental shower stalls must be accessible and have an accessible dressing room (See section 4.35 below).
• Toilet Rooms
  • Each toilet room shall have a 60” turning radius and a clear space of 60” x 60” at the toilet where no lavatory, toilet, urinal, etc, impedes into this space – ASU requirement.
  • Automatic Door Openers are required on all public restrooms, and unisex restrooms. See section 4.13.12 of these standards.
  • Doors shall not swing into clear floor space required for any fixture – ADAAG 4.22.2.
  • Diaper changing stations can be installed in the men’s and women’s public restrooms or any other designated room and are only necessary in those buildings where families might come to visit.
  • Diaper changing stations are not permitted in the accessible toilet stalls – ASU requirement.
  • Diaper changing stations are not permitted in Unisex restrooms – ASU requirement.
  • Wrist-blade handles are acceptable for all non-accessible lavatories.
  • Top of toilet tissue holder, 2 - 3” maximum UNDER the grab bars – ASU requirement.
  • Nothing shall be located over the grab bars – ASU requirement.
• Unisex Restrooms
Unisex restrooms are required on each floor.
Automatic locking devices with Mag-locks are required in all Unisex restrooms.

- Lock cannot be activated until door is in the closed position.
- Occupancy indicator light on corridor side of door is lit when locking device is activated.
- Timers of Automatic locking devices set to 30 minutes.
- Sequence of operation (specific sheets available by calling 480-965-0705) – ASU requirement. No exceptions.
  - To Enter:
    - If exterior light is off the restroom is vacant. Exterior push plate will open the door.
    - When door closes completely, monitor switch is active. Press “Press to lock/unlock” switch to lock.
    - Door will lock.
    - Indicator light goes on
    - “push to open” push plates are inactive
  - To Exit:
    - Press “Push to lock/unlock push plate”
    - Door will unlock. With Mag-lock door cannot be opened without pressing “Push to lock/unlock” plate. This prevents someone from walking out of restroom and locking the door.
    - Indicator light goes out
    - Press “push to open” push plate to open

- One accessible floor urinal is required in each Unisex restroom – ASU requirement.
- Diaper Changing stations are not permitted in Unisex restrooms.
- Coat hook on door or wall at 48” height.
- Light switch at 48” height or be automatic.
- Shower stalls are not allowed in Unisex restrooms – ASU requirement. They become a liability.

4.27 Controls/Operating Mechanisms
- Operable controls should be within reach ranges of 48” maximum and 15” minimum.
  - Thermostats at 48” maximum.
  - Pencil sharpeners at 42” maximum.
  - Vending machines highest operable part shall be 48”.
- Force to operate control not to exceed 5 pounds of pressure.

4.28 Alarms
- Fire alarm pull box at 48” A.F.F. to operable part.

4.30 Signage
- All signage will be provided by ASU’s signage shop and shall be in compliance with ADAAG 4.30.
- Contract may require the contractor to install the restroom signs. Please contact ASU sign shop for heights and locations 480-965-7714.

4.31 Public Telephones
• Phone height to top of coin slot shall be 48”. In bank of phones at least 1 shall be at this height.
• Sides of telephone enclosure shall be 27” clear height.
• Counter height is determined by underside of pay phone equipment, height required for telephone books, and required knee clearance, and TTY requirements.
• Cord length shall be 29” minimum.
• Blue grommet where cord enters handset means phone is compatible with T-switch in hearing aids.

4.32 Fixed tables, fixed seating and work stations
• Fixed desks shall be between 29” and 30” high – ASU requirement.
• Transaction counters in lobbies, shall have the counter a minimum of 36” wide and 34” high.
  • Locate this transaction counter closest to the entry doors so someone in a wheelchair does not have to search for the counter.

4.33 Assembly Facilities (Classrooms, lecture halls and teaching labs)
• Automatic door openers are required on doors that have exterior entrances.
• Install wheelchair accessible signs on entrances to large classrooms to indicate which areas wheelchairs can enter safely. This is especially important in tiered classrooms.
• Fixed wheelchair locations shall be level, stable, firm and slip-resistant and dispersed around room. ADAAG 4.33.4 Dispersed means that wheelchair users shall be able to select whether to sit in the front, center or back of the room. Where impossible to disperse seating, they may be clustered. ADAAG 4.33.3.
• Access to all areas of lecture halls and stages are required – ADAAG 4.33.5. All programs must be accessible - ADAAG Title II II-5.000.
• Classrooms (large and small) to have accessible adjustable teaching stations – ASU requirement.
  • Adjustable tables for students required in each classroom and lecture hall – ASU requirement.
    • Switches on adjustable tables shall be on the pathway side of the table.
  • Allow space and lighting for Interpreters in the front of the room with the lecturer.
• Audio Equipment ADAAG 4.33.6 and 4.33.7.
  • Assistive Listening Capabilities in each room.
  • Captioning capability.
  • For 50 or more fixed seats, 4% of all seating must have a permanent assistive listening system and be within 50 feet of stage, with complete view.
  • Types of listening systems recommended are the magnetic induction loop, infra-red or radio frequency modulation (FM). Signage about this service will be posted by ASU.
• Teaching labs shall have at least 1 adjustable lab table – ASU requirement.

4.35 Dressing and fitting rooms
• Provide a clothes hook at 48” height.

Residential Life Accessible Dorm Rooms
• Locate rooms on the first floor if possible but disperse them through-out the floor so resident will have a choice of location. If the building has an elevator, then accessible rooms shall be on all floors.
• Window sills shall be no higher than 42” so one in a wheelchair can look out – ASU requirement.
• Peep hole on door at accessible height (48”) and standing height (60”) – ASU requirement.
• Door Opener with electric strike. There shall be an automatic door opener (blue pad) inside all accessible dorm rooms and a Remote Automatic door opener on the corridor side of the room. An example of a manufacturer would be Horton model number 7000 or similar. This device is activated with a remote control that the student attaches to her/his wheelchair or has in her/his possession. The 'clicker' has to be dual frequency – ASU requirement.
• Window covering controls to be extra long so they are accessible.
• Adjustable table for desks required in every accessible room.
• Extra outlets are required for equipment.
• Additional adjustable shelving is required.

**Residential Life Accessible Bathrooms**
- Private bathrooms with walls and floor fully tiled.
- Roll in showers (60” minimum) see requirements below under section 4.21.
- Provide additional storage in bathroom.
- Grab bars to be installed for towel racks.

**4.21 Shower Stalls in Accessible Dorm rooms**
- Wheel-in stall of 60” x 30” minimum.
  - Follow ADAAG 4.21 requirements.
    - Shower with flex-hose with control locate at head of shower and not side.
    - Slide pole with adjustment for height of the hose/showerhead.
    - Shower curtain required and not doors.
    - Built in corner shelves or wall niche to hold toiletries.

**4.25 Storage (Closets)**
- Pole and shelf adjustable to be 48” in height – ASU requirement.
- No doors on closets are acceptable, providing the closet is not in view of an open entrance door to the room. ASU requires a minimum of 60” wide x 60” of clear space in front of the closet.
- Extra electrical outlets in closet for equipment.
- Additional adjustable shelving in closet.
  - The light switch to the closets at 48” height with a rocker switch and not toggle switch.

**Designated Access Zone – It’s a Civil Rights Law!**

**Location Requirement**

Room sign locations are on the lever side of the door, 62” inches from the top of the sign to the finished floor. If a sidelight is on the lever side of the door, then the signage SHALL be installed on the sidelight. The glazing of the sidelight shall be a minimum of 18” wide to accommodate the signage.
Tactile/Braille Destination Signs

Consistent sign placement throughout the campus is critical. Wall mounted door signs must be installed so that a person can approach to within three inches of the sign without encountering any protruding objects or standing within the swing of any door.

Checklist

- You must include a minimum maneuvering clearance of 18” on the lever/knob side of the door.
- You must have the federally mandated tactile/Braille room number sign at each permanent destination.
- You must leave adequate wall space on the lever side of the door. The sign is placed 62” from the top of the sign to the finished floor. There can be no obstructions on the wall in the signage area (Thermostats, light switches, molding, etc.)
Appendix 2
ASU Electrical Reliability Standard

Revised December 2009
ASU Electrical Reliability Standard

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ASU Electrical Reliability Standard

A. Scope:

1. Define categories of emergency, standby and normal power needed to serve the various loads at the ASU Tempe Campus.
   a. This standard applies to buildings that are not part of the Tempe Campus, except that references made in this Standard to the Central Plant (CP) and the Combined Heating and Power Plant (CHP) and the associated 4160V generators are not available sources of power for off-campus buildings.
   b. Existing Buildings: Where modifications are required to bring existing buildings in compliance with this Standard, obtain approval from the ASU executive director of Capital Programs Management Group to make required modifications.

2. Establish design, installation and operational criteria in the electrical systems for the reliable delivery of power to each of the categories of emergency, standby and normal power systems.

3. Develop a method to assign the various loads or processes on campus to one of the power system categories.

B. Codes and Standards: The following codes and standards apply to this document. While many of the requirements from these references are stated in this Standard for emphasis and/or interpretation, it is not the intent to re-state all requirements. The absence of a re-statement of any requirement from the list of codes and standards does not relieve the design engineer from compliance with the codes and standards, which are part of the requirements of this document by reference. Where conflicts occur between this Standard and the references below, notify the ASU Project Manager of such conflicts for resolution and direction.

1. ASU Design Guidelines
4. NFPA 70: National Electrical Code - 2008 (in particular, Articles 700, 701 and 702)
5. NFPA 110 Standard for Emergency and Standby Power Systems
6. Uptime Institute - Tier Classification and Performance Standard

1 The terms "Class", "Level", "Tier" or "Type" are not used since these terms are used in one or more of the referenced standards and already have established meanings that would cause confusion or contradiction if used in this document.
C. **Assumptions:** The following assumptions are made:

1. Electrical equipment and components are properly designed to function within their intended application and limits.
2. The design and installation of the electrical system is code compliant.
3. Electrical systems are tested, adjusted and commissioned to meet the design intent.
4. Equipment is operated within its limits and intended use.
5. Personnel are properly trained and qualified to operate the equipment.
6. Equipment is maintained and tested according manufacturer's recommendations and the requirements of applicable codes and standards.

D. **Categories of Power Systems:** For the purposes of the ASU Reliability Standard, the following categories of power systems are defined below, with requirements given for each category. To the extent possible, established definitions are used and tailored to meet the specific needs of ASU.

E. **Emergency System (Category "E"):** Those systems legally required and classed as emergency by municipal, state, federal, or other codes, or by any governmental agency having jurisdiction. These systems are intended to automatically supply illumination, power, or both, to designated areas and equipment in the event of failure of the normal supply or in the event of accident to elements of a system intended to supply, distribute, and control power and illumination essential for safety to human life (NEC 700.1). For each project, submit to the ASU Project Manager a list of loads intended to be connected to this system.

1. **Examples:** Equipment on campus to be connected to this system may include:

   a. Elevators and Lifts - where 4 or more stories, and where they are part of an accessible means of egress
   b. Emergency Egress and Exit Lighting
   c. Fire Detection and Alarm Systems
   d. Fire Pumps
   e. Public Safety and Emergency Voice Communications Systems
   f. Ventilation - where essential to maintain human life (i.e. BSL3 and BSL4 areas).
   g. Fume hoods, ventilation, treatment systems, temperature control, alarm and detection where pyrophoric materials (silane gas), highly toxic or toxic materials are handled or stored.
   h. Industrial Processes - where interruption would produce serious life safety or health hazards.
   i. Other equipment or systems as required by the referenced codes and standards
2. Requirements for the Emergency System:

a. Sources of Power: Loads on the emergency system for each building shall be supplied with two sources of power: the normal power source for the building, and an emergency standby power source connected through an automatic transfer switch located inside of the building served. Depending on availability, capacity and project requirements, the following sources of power for the Emergency System are acceptable on the ASU Tempe Campus:

1. 4160V generators and distribution from the Central Plant (CP)
2. 4160V generators and distribution from the Combined Heating and Power Plant (CHP)
3. Emergency/standby generator(s) located on the premises of the project, with on-premises fuel source.

b. Capacity: The emergency power system shall have adequate capacity and rating for all emergency loads to be started and operated simultaneously. A load study for each project shall be performed and submitted to the ASU Project Manager to determine the required capacity of the emergency power system for the emergency loads of the project, and compared to the available capacity if connecting to an existing emergency source of power.

1. Where connecting to existing generator(s), the existing running load may be determined by metered kW demand data in accordance with NEC 220.87, except that an additional minimum 125% factor shall be applied to account for power factor. Loads that do not normally operate (such as fire pumps and smoke control equipment) shall be added to the metered demand. The simultaneous starting of all emergency loads shall be taken into account in the load calculations.

2. Where multiple fire pumps are connected to the existing generator(s), a demand factor as approved by the ASU Facilities Director may be applied.

c. Tolerance Duration of Outage: The emergency power supply shall be available within 10 seconds of failure of the normal power supply.

d. Duration of Supply: The emergency power supply shall be available for 24 hours minimum (based on the maximum kW rating of the generator), without the need to refuel the source.
1. For buildings with a seismic design category C, D, E, or F as determined in accordance with ASCE 7, the minimum duration of fuel supply shall be increased to 96 hours.

e. **Transfer Equipment**: Automatic transfer switches meeting all UL and NFPA requirements for Emergency/Level 1 installations shall be provided and dedicated to the Emergency System and its loads, and be located inside of the building it serves. Provide bypass isolation for each transfer switch.

f. **Physical Separation of Systems**:

   1. Locate generator(s) either indoors in a dedicated 2-hour rated room, or outdoors in a suitable weather-protected housing within an enclosed, secured equipment yard.

   2. Locate transfer switch(es) and its main distribution in a 1-hour rated room, separate from the normal power equipment.
      
      a. Transfer switches and distribution from the legally-required and optional standby systems are permitted to be in this same room.

   g. **Electrical Separation of Systems (Independent Wiring)**: Wiring from the emergency source and its distribution shall be kept entirely independent of all other wiring and equipment according to NEC 700.9.

      1. Where connecting to the 4160V generators from either CP or CHP (or some other central, shared source), the feeder from these sources shall be dedicated to only the Emergency Systems. Where standby loads within a building are connected to this same feeder (as allowed by this Standard), then the independent wiring shall begin at the first main disconnect or switchboard on the secondary side of the 4160V transformer, where separate vertical sections or separately enclosed disconnects shall be used to serve the separate emergency and standby transfer switches.

h. **Selective Load Pickup and Load Shedding**: Selective load pickup and load shedding is not allowed on the emergency systems, but shall be provided for the standby loads that share a common generator or feeder that serves the emergency system.

i. **Selective Coordination**: Overcurrent devices shall be selectively coordinated per NEC 700.27.
1. Coordination shall be provided for a minimum of 0.1 seconds and above (short time and long time regions). For below 0.1 seconds (instantaneous region), consideration may be given to other factors, such as availability of equipment to provide full coordination in this region, and the increased arc flash hazard that may result in full coordination. A fault current, coordination and arc flash study shall be performed on the emergency system for each project and presented to the ASU Project Manager and code authority for discussion and decision on system coordination.

F. Legally Required Standby Systems (Category "S"):

Those systems required and so classed as legally required standby by municipal, state, federal, or other codes or by any governmental agency having jurisdiction. These systems are intended to automatically supply power to selected loads (other than those classed as emergency systems) in the event of failure of the normal source. Legally required standby systems are typically installed to serve loads, such as heating and refrigeration systems, communications systems, ventilation and smoke removal systems, sewage disposal, lighting systems, and industrial processes, that, when stopped during any interruption of the normal electrical supply, could create hazards or hamper rescue or fire-fighting operations (NEC 701.2 and FPN). For each project, submit to the ASU Project Manager a list of loads intended to be connected to this system.

1. Examples of equipment on campus to be connected to the this system may include:

   a. Smoke Control Systems
   b. Electrically Operated Doors
   c. Heating and Refrigeration Systems - where interruption would create hazards
   d. Fume hoods, ventilation, treatment systems, temperature control, alarm and detection where hazardous materials are handled or stored.
   e. High-rise Buildings - fire command center (lights and power)
   f. Sewage Disposal
   g. Other equipment or systems as required by the referenced codes and standards

2. Requirements for the Legally Required Standby System:

   a. Sources of Power: Loads on this system for each building shall be supplied with two sources of power: the normal power source for the building, and a standby power source connected through an automatic transfer switch located inside of the building served. Depending on availability, capacity and project requirements, the following sources
of power for the Standby System are acceptable on the ASU Tempe Campus:

1. Standby generator(s) located on the premises of the project, with on-premises fuel source.
2. 4160V Generators and distribution from either CP or CHP, for small loads: For small loads where an on-premises generator does not exist or may not be justified, the campus 4160V generator systems may be used, with approval from the ASU Director of Facilities.

b. **Capacity:** The standby power system shall have adequate capacity and rating for all loads intended to operate simultaneously. Starting may be accomplished with load-stepping to minimize generator size due to block load pick up and inrush currents, as long as the Tolerance Duration of Outage is not exceeded. A load study for each project shall be performed and submitted to the ASU Project Manager to determine required capacity of the standby power system for the loads of the project, and compared to the available capacity if connecting to an existing standby source of power.

1. Where connecting to existing generator(s), the existing running load may be determined by metered kW demand data in accordance with NEC 220.87, except that an additional minimum 125% factor shall be applied to account for power factor. Loads that do not normally operate (such as fire pumps and smoke control equipment) shall be added to the metered demand.

2. Applicable NEC demand factors for elevators and non-coincidental loads may be applied to new loads. Submit demand factor analysis together with the load study.

c. **Tolerance Duration of Outage:** The standby power supply shall be available within 60 seconds of failure of the normal power supply. Specific load(s) may require shorter outage duration, and shall be verified with the ASU Project Manager and User groups for each project.

d. **Duration of Supply:** The standby power supply shall be available for 24 hours minimum (based on the maximum kW rating of the generator), without the need to refuel the source. Specific load(s) may require longer duration of supply, and shall be verified with the ASU Project Manager and User groups for each project.
e. **Transfer Equipment:** Automatic transfer switches meeting all UL and NFPA requirements for Legally Required/Level 2 installations shall be used for the Legally-Required Standby System, and be located inside of the building it serves. Provide bypass isolation for each transfer switch.

f. **Physical Separation of Systems:**

1. Locate generator(s) either indoors in a dedicated 2-hour rated room, or outdoors in a suitable weather-protected housing within an enclosed, secured equipment yard.

2. Locate transfer switch(es) and its main distribution in a 1-hour rated room, separate from the normal power equipment.

   a. Transfer switches and distribution may occupy the same room as the Emergency System transfer switch and distribution.

g. **Electrical Separation of Systems (Independent Wiring):** Wiring from the standby source and its distribution shall be kept entirely independent of the normal power wiring and equipment.

1. Where standby loads within a building are connected to the 4160V generators and feeder (as allowed by this Standard), then the independent wiring shall begin at the first main disconnect or switchboard on the secondary side of the 4160V transformer, where separate vertical sections or separately enclosed disconnects shall be used to serve the separate emergency and standby transfer switches.

h. **Selective Load Pickup and Load Shedding:** Selective load pickup and load shedding is permitted providing all other requirements are met, in order of highest priority to lowest priority as listed below. Submit proposed load pickup/load shed scheme to the ASU Project Manager and User groups for approval.

1. Emergency Circuits (never shed)
2. Legally-Required Standby Circuits
3. Critical Standby
4. Less Critical Standby

i. **Selective Coordination:** Overcurrent devices shall be selectively coordinated per NEC 701.18.
1. Coordination shall be provided for a minimum of 0.1 seconds and above (short time and long time regions). For below 0.1 seconds (instantaneous region), consideration may be given to other factors, such as availability of equipment to provide full coordination in this region, and the increased arc flash hazard that may result in full coordination. A fault current, coordination and arc flash study shall be performed on the standby system for each project and presented to ASU (Authority Having Jurisdiction) for discussion and decision on system coordination.

G. Critical Standby Systems: Critical standby systems are those systems intended to supply power to facilities where life safety does not depend on the performance of the system. Critical standby systems are typically installed to provide an alternate source of electric power for such facilities as industrial and commercial buildings to serve loads such as heating and refrigeration systems, data processing and communications systems, and industrial processes that, when stopped during any power outage, could cause discomfort, serious interruption of the process, damage to the product or process, or the like2 (NEC 702.2 and FPN). This category will be divided into three subcategories:

1. Critical (Category "C1"): Those systems intended to supply power to facilities or processes that, when stopped or disrupted during any power outage, could cause substantial economic loss, damage products or animals, result in loss of experimental, research or computational data, or the like. For each project, submit to the ASU Project Manager a list of loads intended to be connected to this system.

   a. Examples of equipment on campus to be connected to the this system may include:

   1. Critical Research Lab Equipment
   2. Freezers and Refrigerators - Labs
   3. Vivariums: HVAC (with control systems) and Lighting
   4. Elevators for Research and Other Critical Buildings (if not already on the Emergency System as required by that section).
   5. Data Centers - power and air conditioning
   6. Telecommunications Systems (UTO), MDF Rooms - core locations: power and air conditioning
   7. Building Automation Systems - control panels and circuits
   8. Energy Information System (EIS) - control

2 The NEC refers to these systems as "Optional Standby", however, ASU prefers the term "Critical Standby" to avoid the perception among those operating and using the critical facilities that these systems might be an "option" for their critical buildings. When a building or loads within a building are deemed "critical", then the standby requirements in this Standard are not an option.
9. Mass Notification Systems

2. **Less Critical (Category "C2")**: Those systems intended to supply power to facilities or processes that, when stopped during any power outage, could cause modest economic loss, production loss, discomfort or inconvenience. For each project, submit to the ASU Project Manager a list of loads intended to be connected to this system.
   a. Examples of equipment on campus to be connected to this system may include:
      1. Less Critical Lab equipment
      2. Vivariums: Humidification
      3. Freezers and Refrigerators - Food Service
      4. Telecommunications Systems (UTO), MDF Rooms - non-core locations, IDF Rooms: power and air conditioning (including control systems)
      5. Departmental Server Closets (less critical) - power and air conditioning
      6. Security Systems
      7. Points of Sale

3. **Temporary Critical (Category "C3")**: Those systems intended to supply power to temporary facilities, events or processes that, when stopped during any power outage, could cause economic loss, production loss, discomfort or inconvenience. These facilities serve critical functions on a temporary or not regularly recurring basis.
   a. Examples of equipment on campus to be connected to this system may include:
      1. Temporary Emergency Shelters
      2. Special Events

4. **Requirements for Critical, Less-Critical and Temporary Critical Standby Systems**: 
   a. **Sources of Power**: Loads on this system for each building shall be supplied with two sources of power: the normal power source for the building, and a standby power source connected through a transfer switch. The normal source shall be fed from a looped campus distribution system normally supplied from a minimum of two separate APS substation transformers. For Critical buildings, it is preferred, but not required, to provide a loop that is fed from both CHP and one other independent APS source. Depending on availability,
capacity and project requirements, the following sources of power for the Critical Standby systems are acceptable on the ASU Tempe Campus:

1. Standby generator(s) located on the premises of the project, with on-premises fuel source.

2. Where an on-premises generator is not provided, the 4160V generators and distribution from either CP or CHP may be used for the small, incidental critical loads that occur in every building, for example:
   a. Telecommunications systems (UTO rooms): power and air conditioning
   b. Security Systems
   c. Points of Sale
   d. Building Automation Systems - control panels and circuits.


   b. **Capacity:** The Critical Standby power system shall have adequate capacity and rating for all loads intended to operate simultaneously. Starting may be accomplished with load-stepping to minimize generator size due to block load pick up and inrush currents, as long as the Tolerance Duration of Outage is not exceeded. A load study for each project shall be performed and submitted to the ASU Project Manager to determine required capacity of the standby power systems for the loads of the project, and compared to the available capacity if connecting to an existing standby source of power.

   1. Where connecting to CHP for normal power, or existing generator(s) for standby power, the existing load may be determined by metered kW demand data in accordance with NEC 220.87, except that an additional minimum 125% factor shall be applied to account for power factor. Loads that do not normally operate (such as fire pumps connected to emergency systems or smoke control equipment connected to legally required standby systems or backup air conditioning equipment connected to critical systems) shall be added to the metered demand.

   2. Applicable NEC demand factors may be applied to new loads. Submit demand factor analysis together with the load study.
c. **Tolerance Duration of Outage:** The tolerance of power outage duration will be dictated by each specific critical, less-critical or temporary critical standby load and shall be verified with the ASU Project Manager and User groups during design. The time in which the critical standby power source becomes available shall not affect its ability to supply the legally-required standby and emergency loads.

d. **Duration of Supply:** The standby power supply shall be available for 24 hours minimum, without the need to refuel the source. Specific load(s) may require longer duration of supply, and shall be verified with the ASU Project Manager and User groups for each project.

e. **Transfer Equipment:** Critical loads shall be supplied with automatic transfer switch(es) meeting all UL and NFPA requirements for Legally Required/Level 2 installations, and be provided with bypass isolation. Less-critical and temporary loads shall be supplied with an automatic or manual transfer switch. Bypass isolation is permitted but not required for less-critical and temporary loads.

   1. Transfer equipment for critical and less-critical loads shall be provided with a transfer-inhibit and load-shed contact or other communication means that is capable of remotely shedding the connected loads from the standby power source. Provide interface to the standby source to shed loads in the order of priority (lowest priority shed first) if the source becomes overloaded.

f. **Physical Separation of Systems:**

   1. Locate generator(s) either indoors in a dedicated 2-hour rated room, or outdoors in a suitable weather-protected housing within an enclosed, secured equipment yard.

   2. Locate transfer switch(es) and its main distribution within the building it serves.

g. **Electrical Separation of Systems (Independent Wiring):** Wiring from the critical standby source and its distribution shall be kept entirely independent of the normal power wiring and equipment.

   1. Where connecting to the 4160V generators from either CP or CHP (or some other central, shared source), the feeder from these sources shall be dedicated to only the Emergency Systems. Where critical standby loads within a building are connected to the same feeder (as allowed by this Standard), then the independent wiring shall begin at the first main...
h. **Selective Load Pickup and Load Shedding:** Selective load pickup and load shedding is permitted providing all other requirements are met, in order of highest priority to lowest priority as listed below. It shall be required for the standby loads that share a common generator or feeder that serves the emergency system. Submit proposed load pickup/load shed scheme to the ASU Project Manager and User groups for approval:

1. Emergency Circuits (never shed)
2. Legally-Required Standby Circuits
3. Critical Standby
4. Less Critical Standby

i. **Selective Coordination:** Overcurrent devices for critical standby systems shall be selectively coordinated.

1. Coordination shall be provided for a minimum of 0.1 seconds and above (short time and long time regions). For 0.1 seconds and below (instantaneous region), consideration may be given to other factors, such as availability of equipment to provide full coordination in this region, and the increased arc flash hazard that may result in full coordination. A fault current, coordination and arc flash study shall be performed on the standby system for each project and presented to the ASU (Authority Having Jurisdiction) for discussion and decision on system coordination.
2. Where ground fault protection of equipment is required by the NEC, a second level of ground fault protection downstream from the main ground fault protective device shall be considered to improve reliability and selective coordination of the ground fault protective system.

**H. Normal Power System (Category "N"):** Any system not classified above, or without emergency or standby requirements.

1. **Requirements for the Normal Power System:**

   a. **Sources of Power:** Loads on the normal power system for each building shall be supplied by an APS feeder from one of the ASU APS service points on campus.
1. The distribution shall be connected in a looped system configuration such that the system can be sectionalized and maintain availability of the normal source to the building it serves. The normal source shall fed from a looped campus distribution system normally supplied from a minimum of two separate APS substation transformers. For Critical buildings, it is preferred, but not required, to provide a loop that is fed from both CHP and one other independent APS source. Main distribution switchgear that serves campus loops shall be provided with a bypass circuit breaker for each feeder circuit breaker in the switchgear lineup.

I. Uninterruptible Systems: Those systems intended to supply power to equipment or processes that cannot tolerate more than 1/4-cycle (4ms) power outage, the result of which would be a hard crash and loss of data. This typically includes computer hardware and other data processing equipment. This category is a subset of one of the power categories described above and will be divided into five subcategories. Reference is made to "Tier Levels" which is taken and adapted from the Uptime Institutes Tier Classification System (www.uptimeinstitute.org)

1. Uninterruptible - Tier 0 (Category "U0"): Systems requiring uninterruptible power during a normal power outage, and can tolerate a soft shutdown to save data and programs. During the shutdown time, significant heat is not produced that would damage the equipment in the absence of air conditioning. When normal power is restored, the equipment (and air conditioning) is restarted and the process resumes. For each project, submit to the ASU Project Manager a list of loads intended to be connected to this system.

   a. **Examples** of equipment on campus to be connected to the this system may include:

   1. Small server rooms (other than UTO equipment rooms) that serve individual departments.
   2. Small lab equipment with data processing.

   b. **Requirements for Uninterruptible Category "U0":**

   1. **Sources of Power:** Computer and data processing equipment on this system shall be supplied with a UPS system that is fed from the normal power source for the building. Standby power is not provided for the UPS or the air conditioning serving the equipment room. The UPS source may be a small rack-mounted unit, or a central UPS system where the building is provided with one.
2. **Capacity:** The UPS system shall have adequate capacity and rating for all computer or data processing equipment loads, including future projected loads, plus 25%.

3. **Duration of Supply:** The UPS battery supply shall allow adequate time to perform a soft shutdown of the computer and data processing equipment. Verify battery supply time with the ASU Project Manager and User groups during design.

4. **Redundancy:** Not required.

5. **Selective Coordination:** Not required.

2. **Uninterruptible - Tier 1 (Category "U1"):** Those systems requiring uninterruptible power during a normal power outage and are required to maintain operation. Air conditioning serving the room is required to have standby power. These systems are less critical and can tolerate occasional outages due to planned maintenance or unplanned failures, and therefore no redundancy is planned in the UPS and air conditioning for these systems. For each project, submit to the ASU Project Manager a list of loads intended to be connected to this system.

   a. **Examples** of equipment on campus to be connected to the this system may include:

      1. Small UTO IDF server closets in each building.
      2. Non-Core UTO MDF rooms in each building.

   b. **Requirements for Uninterruptible Category "U1":**

      1. **Sources of Power:** Computer and data processing equipment on this system shall be supplied with a UPS system that is fed from the critical standby power source for the building. Air conditioning serving the computer room and UTO rooms is also connected to standby power. The UPS source may be rack-mounted units located in each closet, or a central UPS system where the building is provided with one.

      2. **Capacity:** The UPS system shall have adequate capacity and rating for all computer and data processing equipment loads, including future projected loads, plus 25%.

      3. **Duration of Supply:** Minimum battery time of 10 minutes, however, more battery time may be required depending on specific application or user requirements. Verify battery supply time with the ASU Project Manager and User groups during design.

      4. **Redundancy:** Not required.

      5. **Selective Coordination:** System shall be selectively coordinated as per the Critical Standby Requirements.
c. **Small UTO IDF Rooms in Buildings without a Standby Power System:** Where UTO IDF rooms are located in buildings without a standby power system, and the computer equipment load is less than 10,000 watts, extended UPS battery time may be provided in lieu of a standby power source, with battery run time of not less than 4 hours based on the equipment load. Under this condition, the computer equipment shall operate without air conditioning with no damage or failure to the computer equipment during the battery run time.

3. **Uninterruptible - Tier 2 (Category "U2"):** Those systems requiring uninterruptible power during a normal power outage and are required to maintain operation. Air conditioning serving the room is required to have standby power. These systems are critical but can tolerate occasional outages due to unplanned failures. Redundancy is required in the UPS and air conditioning systems, but only a single path is provided to the equipment. For each project, submit to the ASU Project Manager a list of loads intended to be connected to this system.

   a. Examples of equipment on campus to be connected to the this system may include:

      1. None identified at this time

b. **Requirements for Uninterruptible Category "U2":**

   1. **Sources of Power:** Computer and data processing equipment on this system shall be supplied with a UPS system that is fed from the critical standby power source for the building. Air conditioning serving the computer room is also connected to standby power. The UPS source may be rack-mounted units located in each closet, or a central UPS system where the building is provided with one.
   2. **Capacity:** The UPS system shall have adequate capacity and rating for all computer or data processing equipment loads, including future projected loads, plus 25%.
   3. **Duration of Supply:** Minimum battery time of 10 minutes, however, more battery time may be required depending on specific application or user requirements. Verify battery supply time with the ASU Project Manager and User groups during design.
   4. **Redundancy:** One additional component (N+1 redundancy) in the UPS and air conditioning systems with a single power path to the equipment.
5. **Selective Coordination:** System shall be selectively coordinated as required by the Critical Standby Requirements above.

4. **Uninterruptible - Tier 3 (Category "U3"):** Those systems requiring uninterruptible power during a normal power outage and are required to maintain operation. Air conditioning serving the room is required to have standby power. These systems are more critical and cannot tolerate outages due to maintenance or unplanned failures. Redundancy is required in the UPS and air conditioning systems, and dual power paths are provided from the UPS output to each data processing equipment rack. For each project, submit to the ASU Project Manager a list of loads intended to be connected to this system.

   a. Examples of equipment on campus to be connected to the this system may include:

   1. Main UTO Telecommunications Core MDF's for each building
   2. Main UTO Campus Data Centers
   3. Equipment as required by contract to be reliable, for example, the JPL/NASA research programs.
   5. Energy Information System equipment.

   b. **Requirements for Uninterruptible Category "U3":**

   1. **Sources of Power:** Computer and data processing equipment on this system shall be supplied with a UPS system that is fed from the critical standby power source for the building. Air conditioning serving the computer rooms and UTO rooms is also connected to optional-critical standby power. The UPS source will typically be a central system, with isolated and redundant components.

   2. **Capacity:** Each redundant UPS system shall have adequate capacity and rating for all computer or data processing equipment loads, including future projected loads, plus 25%. Where equipment load information cannot be obtained, a basis of 100 watts/sf of equipment room space shall be used, and the system designed with modular components to easily expand system without requiring a shutdown.

   3. **Duration of Supply:** Minimum battery time of 10 minutes for each redundant UPS module at full load, however, more battery time may be required depending on specific application or user requirements. Verify battery supply time with the ASU Project Manager and User groups during design.
4. **Redundancy**: UPS system consists of two separate, redundant systems, each with one or more UPS modules sized for the full load of the equipment. Separate power distribution paths are provided from each system to the equipment racks. Dual power cords of the data processing equipment plug into each system. If one system fails, the other system assumes the full load. Air conditioning requires "N+1" redundancy at a minimum, with a reliable source of backup cooling when depending only on the campus central chilled water supply.

5. **Selective Coordination**: System shall be selectively coordinated as required by the Critical Standby Requirements above.

5. **Uninterruptible - Tier 4 (Category "U4")**: Those systems requiring uninterrupted power during a normal power outage and are required to maintain operation under all conditions. Air conditioning serving the room is required to have redundant standby power. These systems are most critical and cannot tolerate outages under any circumstance. Total system redundancy is required in the UPS and air conditioning systems, and all normal and standby paths from the utility source to each data processing equipment rack. For each project, submit to the ASU Project Manager a list of loads intended to be connected to this system.

   a. Examples of equipment on campus to be connected to this system may include:

   1. None identified at this time

   b. **Requirements for Uninterruptible Category "U4"**:

   1. **Sources of Power**: Computer and data processing equipment on this system shall be supplied with a two separate UPS systems, each connected to separate utility and critical standby sources that are separate and redundant from each other. Air conditioning serving the computer room is also connected to separate and redundant power sources.

   2. **Capacity**: Both or all UPS systems shall have adequate capacity and rating for all computer or data processing equipment loads, including future projected loads, plus 25%. Where equipment load information cannot be obtained, a basis of 100 watts/sf of equipment room space shall be used, and the system designed with modular components to easily expand the system without requiring a shutdown.

   3. **Duration of Supply**: Minimum battery time of 10 minutes for each redundant UPS system at full load, however, more battery time may be required depending on specific application or user
requirements. Verify battery supply time with the ASU Project Manager and User groups during design.

4. **Redundancy:** Total "2N" system isolation and redundancy from the power sources (including utility feeds, main transformers and generators) to the data processing equipment. Dual power cords of the data processing equipment plug into each system. If one system fails, the other system assumes the full load. Air conditioning requires double components connected to the separate power systems. A reliable source of backup cooling is required when depending only on the campus central chilled water supply.

5. **Selective Coordination:** System shall be selectively coordinated as per the Critical Standby Requirements.
### Table 1: Summary of Power System Categories and Criteria

<table>
<thead>
<tr>
<th>Power System</th>
<th>Source</th>
<th>Tolerance of Outage</th>
<th>Duration of Supply</th>
<th>Load Add / Shed</th>
<th>Transfer Equipment</th>
<th>Separation of Systems</th>
<th>Selective Coordination</th>
<th>Redundancy (see note 1)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>E</strong></td>
<td>CP or CHP 4160V Gen., Local Gen.</td>
<td>10 SEC.</td>
<td>24 HR</td>
<td>NO</td>
<td>ATS w/Bypass</td>
<td>YES</td>
<td>YES</td>
<td>Not Required</td>
</tr>
<tr>
<td><strong>S</strong></td>
<td>Local Gen., Limited CP or CHP 4160V Gen.</td>
<td>60 SEC</td>
<td>24 HR</td>
<td>Allowed</td>
<td>ATS w/Bypass</td>
<td>YES</td>
<td>YES</td>
<td>Not Required</td>
</tr>
<tr>
<td><strong>C1</strong></td>
<td>Local Gen., Limited CP or CHP 4160V Gen.</td>
<td>Varies</td>
<td>Varies (24 HR min.)</td>
<td>Allowed</td>
<td>ATS w/Bypass</td>
<td>Recommended</td>
<td>YES, plus 2-level GFI</td>
<td>Loops plus Secondary main-tie-main</td>
</tr>
<tr>
<td><strong>C2</strong></td>
<td>Local Gen., Limited CP or CHP 4160V Gen.</td>
<td>Varies</td>
<td>Varies (24 HR min.)</td>
<td>Allowed</td>
<td>ATS or Manual</td>
<td>Not Required</td>
<td>YES</td>
<td>Not Required</td>
</tr>
<tr>
<td><strong>C3</strong></td>
<td>Local Gen or Portable Gen</td>
<td>Varies</td>
<td>Indefinite with re-fueling</td>
<td>N/A</td>
<td>ATS or Manual</td>
<td>Not Required</td>
<td>Not Required</td>
<td>Not Required</td>
</tr>
<tr>
<td><strong>N</strong></td>
<td>APS for all Buildings CHP + APS for Critical Buildings</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>Per NEC</td>
<td>Looped System</td>
</tr>
<tr>
<td><strong>U1</strong></td>
<td>Generator plus UPS</td>
<td>4 ms</td>
<td>10 min. UPS 24 HR. Gen</td>
<td>NO</td>
<td>ATS w/Bypass for Gen.</td>
<td>Not Required</td>
<td>Not Required</td>
<td>&quot;N&quot;</td>
</tr>
<tr>
<td><strong>U2</strong></td>
<td>Generator plus UPS</td>
<td>4 ms</td>
<td>10 min. UPS 24 HR. Gen</td>
<td>NO</td>
<td>ATS w/Bypass for Gen.</td>
<td>Not Required</td>
<td>YES</td>
<td>&quot;N+1&quot; with single path</td>
</tr>
<tr>
<td><strong>U3</strong></td>
<td>Generator plus UPS</td>
<td>4 ms</td>
<td>10 min. UPS 24 HR. Gen</td>
<td>NO</td>
<td>ATS w/Bypass for Gen</td>
<td>Not Required</td>
<td>YES</td>
<td>&quot;N+1&quot; &quot;2N&quot; for UPS and distribution</td>
</tr>
<tr>
<td><strong>U4</strong></td>
<td>Generator plus UPS</td>
<td>4 ms</td>
<td>10 min. UPS 24 HR. Gen</td>
<td>NO</td>
<td>ATS w/Bypass for Gen</td>
<td>Not Required</td>
<td>YES</td>
<td>&quot;2N&quot;</td>
</tr>
<tr>
<td><strong>U0</strong></td>
<td>UPS Only</td>
<td>4 ms</td>
<td>10 min.</td>
<td>Soft Shutdown</td>
<td>None.</td>
<td>Not Required</td>
<td>Not Required</td>
<td>&quot;N&quot;</td>
</tr>
</tbody>
</table>

1. **Definition of Redundancy Terms:**
   - "N": The number of components required to serve the capacity of the system. If one component fails, the system fails.
   - "N+1": The number of components required to serve the capacity of the system, plus (1) redundant component. If one component fails, the system maintains operation.
   - "2N": A system of "N" components required to serve the capacity of the system, plus one independent, redundant system of "N" components. If one system fails, the other system maintains operation.
J. Requirements Common to All Categories of Power

1. Power Quality
   
a. Surge Protective Device (SPD): Provide SPD at the main switchboard or distribution panel for each of the normal, emergency and standby systems. Provide at least one additional level of SPD for branch panelboards that serve sensitive electronic equipment.
   b. Lightning Protection: Provide a lightning risk assessment analysis for each building per NFPA 780. When the result is "recommended", provide a lightning protection system for the building with a UL Master label.

2. Grounding: In addition to NEC requirements, comply with the following grounding requirements:
   
a. All feeders and branch circuits shall be provided with an insulated equipment grounding conductor. The conduit system shall be bonded per NEC, but not be the only path for equipment grounding.
   c. Telecommunications and server closets shall be provided with a ground bar, bonded to the electrical grounding electrode system.

3. Voltage Drop: Branch circuit conductors shall be sized to keep voltage drop to 3% or below. The total voltage drop on branch circuits and feeders shall not exceed 5%.

4. Sustainability
   
a. Generator Emissions. Generators shall comply with the highest emissions standards available and in accordance with Tier 4 EPA regulations. The use of diesel particulate filters with oxidation catalysts and burners may be required to reach this level.
   b. Carbon Footprint: The campus carbon footprint shall not be increased by adding generators.

5. Testing and Maintenance of Generators
   
a. Generators shall be tested and maintained according to the NFPA 110 Standard (Chapter 8) and manufacturer's recommendations and instruction manuals.
      
      1. This testing shall include at least a monthly test for 30 minutes under load. Refer to NFPA110 and manufacturer for a comprehensive list of testing and maintenance requirements.
6. **Labeling**: Equipment labels shall be provided per the current ASU Design Guidelines, with the following modifications:

   a. Labels for all equipment shall be color coded according to the power system category it is served by, and preceded by the abbreviation used for the category. The following color codes and prefixes shall be used:

      1. Normal System: Black background with white text; "N" prefix.
      2. Emergency System: Red background with white text; "E" prefix.
      3. Legally-Required Standby System: White background with red text; "S" prefix.
      4. Critical Standby System: Orange background with white text; "C1" prefix.
      6. Uninterruptible Systems (All): Blue background with white text; "UX" prefix, where X = 0, 1, 2, 3 or 4.

   b. Circuit Identification on Outlets: Outlets connected to an emergency or standby source shall be identified on the face plate with the circuit number serving the outlet, using computer printed clear stick-on labels. Wiring devices connected to a standby generator shall be red devices and plates.

   c. Panel schedules shall be updated whenever additions or modifications are made to circuits.

7. **Metering, Monitoring and Notification**

   a. Provide digital metering at overcurrent protective devices for campus medium voltage loops, for main panelboards or switchboards on each of the normal, emergency and standby systems. Meters shall be networked and report back to Central Plant using the campus Energy Information Systems (EIS) fiber network.

   b. Provide monitoring of each transfer switch for status and position of switch, and report to Central Plant through the EIS network.

   c. Make provisions for automatic notification to Central Plan operations when emergency and critical loads are transferred to the standby generator source.

8. **Electrical Reliability Survey**

   a. For each new project, perform an electrical reliability survey to assess the need for different categories or emergency, standby and uninterruptible power. An Electrical Reliability Survey is included in the Appendix that will assist the design engineer and ASU project manager in this assessment. Submit the results of the survey and propose equipment and loads for each system. A Table is provided for common types of loads on ASU Campus that require emergency, standby and uninterruptible power.
9. Reliability Analysis
   
a. For each new project, submit an electrical reliability analysis to the ASU project manager. The analysis shall include a narrative of the approach for the project to comply with this Standard, with references and compliance statements to each section of this Standard.

10. Update of Campus Distribution System One-Line and Model
   
a. For each new project, update the campus medium-voltage system one-line diagram.
b. For each new project, update the campus electrical design analysis software model for load flow, fault currents and coordination. Presently the analysis software used is SKM Powertools.

11. Commissioning
   
a. All systems serving emergency, standby and critical applications shall be commissioned by an independent (3rd party) commissioning agent per ASHRAE Guideline 0-2005 standards. This commissioning process shall begin in the early design phase of the project, to ensure that this Standard is met, and continue through building occupancy.

12. System Design and Operation and Maintenance Documentation
   
a. A Facility Operators Manual shall be provided for each project. This manual shall be customized for the project to fit the scope of work and complexity of the project. The manual shall be organized and presented according to the ASHRAE Guideline 4 Preparation of Operating and Maintenance Documentation for Building Systems.

13. Training
   
a. Proper training is key to successful turnover and operation of the building. Training requirements shall be customized to fit the scope of work and complexity of the project. Training shall be provided for all major mechanical, electrical and control systems. Training shall include hands-on experience and include DVD recording and training documents and materials.

14. ASU Reliability Standard Update
   
a. This Standard shall be reviewed and updated on a biannual (or more frequent) basis.
<table>
<thead>
<tr>
<th>Load / Equipment</th>
<th>Max. Tolerance Duration of Outage</th>
<th>Minimum Duration of Supply</th>
<th>Category of Power System</th>
<th>Justification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Emergency and Life Safety</td>
<td>10 s</td>
<td>2 hr</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Emergency and Life Safety, Seismic C - F</td>
<td>10 s</td>
<td>96 hr</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>UTO Main Data Centers (equipment)</td>
<td>4 ms</td>
<td>15 min batt., 24 hr gen.</td>
<td>X</td>
<td>U3</td>
</tr>
<tr>
<td>UTO Main Data Centers (A/C)</td>
<td>1 min</td>
<td>24 hr</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>UTO Core MDF Rooms (equipment)</td>
<td>4 ms</td>
<td>15 min batt., 24 hr gen.</td>
<td>X</td>
<td>U3</td>
</tr>
<tr>
<td>UTO Core MDF Rooms (A/C)</td>
<td>1 min</td>
<td>24 hr</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>UTO non-core MDF Rooms (equipment)</td>
<td>4 ms</td>
<td>10 min batt., 24 hr gen.</td>
<td>X</td>
<td>U1</td>
</tr>
<tr>
<td>UTO non-core MDF Rooms (A/C)</td>
<td>1 min</td>
<td>24 hr</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>UTO IDF Rooms (equipment)</td>
<td>4 ms</td>
<td>10 min batt., 24 hr gen.</td>
<td>X</td>
<td>U1</td>
</tr>
<tr>
<td>UTO IDF Rooms (A/C)</td>
<td>1 min</td>
<td>24 hr</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Energy Information Systems</td>
<td>1 min</td>
<td>24 hr</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Department Server Rooms</td>
<td>4 ms</td>
<td>15 min batt.</td>
<td></td>
<td>U0</td>
</tr>
<tr>
<td>Vivarium Ventilation</td>
<td>10 min.</td>
<td>24 hr</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Load / Equipment</td>
<td>Max. Tolerance Duration of Outage</td>
<td>Minimum Duration of Supply</td>
<td>Category of Power System</td>
<td>Justification</td>
</tr>
<tr>
<td>----------------------------------</td>
<td>----------------------------------</td>
<td>-----------------------------</td>
<td>--------------------------</td>
<td>---------------------------------------------------</td>
</tr>
<tr>
<td>Vivarium Heating and A/C</td>
<td>50 min.</td>
<td>24 hr</td>
<td>X</td>
<td>Prevent animal loss; Prevent research loss</td>
</tr>
<tr>
<td>Vivarium Elevators</td>
<td>1 hour</td>
<td>24 hr</td>
<td>X</td>
<td>Transport of animals</td>
</tr>
<tr>
<td>Research Freezers</td>
<td>1 min</td>
<td>24 hr / indefinite</td>
<td>X</td>
<td>Prevent research loss</td>
</tr>
<tr>
<td>Fume Hoods, Highly Toxic</td>
<td>10 s</td>
<td>24 hr</td>
<td>X</td>
<td>Protection of Human Life</td>
</tr>
<tr>
<td>Fume Hoods, Hazardous</td>
<td>1 min</td>
<td>24 hr</td>
<td>X</td>
<td>Protection of Health and Safety</td>
</tr>
<tr>
<td>BSL 3 and 4 Areas</td>
<td>10 s</td>
<td>24 hr</td>
<td>X</td>
<td>Protection of Human Life</td>
</tr>
<tr>
<td>BSL 1 and 2 Areas</td>
<td>1 min</td>
<td>24 hr</td>
<td>X</td>
<td>Protection of Health and Safety</td>
</tr>
<tr>
<td>JPL Research (equipment)</td>
<td>4 ms</td>
<td>15 min batt. 75 hr gen.</td>
<td>X</td>
<td>U3 Compliance with JPL Contract</td>
</tr>
<tr>
<td>JPL Research (A/C)</td>
<td>1 min</td>
<td>75 hr</td>
<td>X</td>
<td>Compliance with JPL Contract</td>
</tr>
<tr>
<td>Building Automation System</td>
<td>1 min</td>
<td>10 min batt. 24 hr gen.</td>
<td>X</td>
<td>U1</td>
</tr>
<tr>
<td>Points of Sale</td>
<td>10 min</td>
<td>8 hr</td>
<td>X</td>
<td>Continuation of revenue</td>
</tr>
<tr>
<td>Emergency Notification Systems</td>
<td>1 min</td>
<td>24 hr</td>
<td>X</td>
<td>Continuation of emergency communications</td>
</tr>
<tr>
<td>Wireless Comm. Systems (cell phone and repeater towers)</td>
<td>10 min</td>
<td>24 hr</td>
<td>X</td>
<td>Continuation of communications</td>
</tr>
<tr>
<td>Load / Equipment</td>
<td>Max. Tolerance Duration of Outage</td>
<td>Minimum Duration of Supply</td>
<td>Category of Power System</td>
<td>Justification</td>
</tr>
<tr>
<td>----------------------------------</td>
<td>----------------------------------</td>
<td>----------------------------</td>
<td>--------------------------</td>
<td>-----------------------------------------------------</td>
</tr>
<tr>
<td>Temporary Emergency Shelters</td>
<td>Depends on availability of portable gen</td>
<td>Indefinite with re-fueling</td>
<td>X</td>
<td>Continuation of shelter during community disaster</td>
</tr>
<tr>
<td>Special Events</td>
<td>1 minute (portable gen connected)</td>
<td>Duration of event</td>
<td>X</td>
<td>Continuation of event; Continue revenue</td>
</tr>
<tr>
<td>(Other)</td>
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SECTION II

DESIGN GUIDELINES

The Design Guidelines are to be used as a starting point in the development of project specifications. Except as otherwise noted herein, these Design Guidelines are not specifications and are not be used as the project specifications. The Design Professional (DP) is expected to generate individual project specifications per these guidelines.

These guidelines may require modification to meet the needs of a specific project. Deviations from these guidelines are to be approved by CPMG in writing and noted in project documentation.

DIVISION 01 - GENERAL REQUIREMENTS

The Division 01 specifications are included with each project as a part of the ASU Master Front End Specification. These specifications are included in the CMAR Operating Guide and are not to be edited by the DP. Recommended changes to the Design Guidelines should be forwarded to the Capital Programs Management Group.

Use the following section numbering when referencing to/from other specification sections.

01 11 00 SUMMARY OF WORK
01 21 00 ALLOWANCES
01 23 00 ALTERNATIVES
01 31 13 COORDINATION
01 31 19 PROJECT MEETINGS
01 32 16 CONSTRUCTION SCHEDULE
01 33 00 SUBMITTALS
01 33 23 SHOP DRAWINGS, PRODUCT DATA, SAMPLES
01 35 16 ALTERATIONS
01 42 13 ABBREVIATIONS
01 42 19 APPLICABLE STANDARDS
01 45 00 QUALITY CONTROL
01 45 29 TESTING LABORATORY SERVICES
01 50 00 TEMPORARY FACILITIES AND CONTROLS
01 60 00 MATERIAL AND EQUIPMENT
01 71 23 FIELD ENGINEERING
01 73 29 CUTTING AND PATCHING
01 74 00 CLEANING
01 77 00 PROJECT CLOSEOUT
01 78 23 OPERATION AND MAINTENANCE DATA
01 78 39 PROJECT RECORD DOCUMENTS
**Description**

This section includes site, building and selective demolition. The AE shall accurately define the scope of the demolition effort required for the project. Whenever possible a demolition plan shall be created to graphically show the extent of the demolition work.

**Design Standard**

A. Provisions shall be made in the documents to require that all demolition work be performed without disruption to adjacent occupied areas, i.e., off hours work. Only when the anticipated demolition work will not present a disruption to the user or occupant can the assumption be made that it can be conducted at any time.

B. Demolition work is usually associated with trash and dust. Appropriate provisions shall therefore be made to address mitigation procedures in the demolition work.

C. The demolition plan shall identify all materials/equipment, etc., which are to be reused and/or salvaged by either ASU or the contractor. It is important to keep in mind that all equipment and building material is ultimately the property of ASU and only when its salvage cost exceeds its usable value is it to be considered unwanted. This determination can only be made by ASU.

D. A complete investigation of the area(s) shall be performed so that all existing aspects and elements affected by the project are either removed under the demolition plan or incorporated into the new work with the installation drawings, i.e., existing/abandoned outlets, thermostats, trees, etc.

E. Other than items which are to be reused, there are basically 2 groups of salvagable material presented with nearly all projects. Care must be exercised when handling all salvageable material so as to maintain its value.

1. Items which are always salvaged by ASU:
   
   a. LED exit lights.  
   b. Chalk/white boards.  
   c. EMCS equipment.  
   d. Meters (all kinds).  
   e. Door hardware.  
   f. Drinking fountains.  
   g. Window blinds.  
   h. Backflow preventers.  
   i. Fire alarm devices.  
   j. Simplex equipment.  
   k. Lab fixtures.  
   l. Lab equipment (hoods).  
   m. Specimen, historic, heritage and memorial trees.

2. Items which ASU may elect to salvage. Depending on the item, ASU will determine on a case by case basis whether salvage is warranted. The following is a representative, but not conclusive, list of items in which salvage may be considered.
a. Wood/Hollow Metal doors.
b. Electrical panels.
c. Mechanical equipment.
d. Ceiling diffusers.
e. Projection screens.
f. Mirrors.
g. Irrigation equipment.
h. Refrigeration equipment.
i. Plumbing fixtures.
j. Casework.
k. Disconnect switches.
l. Elevator equipment.
m. Soap/Paper dispensers.
n. Clocks.
o. Access doors.
p. Landscape plantings (with the exception of specimen, historic, heritage and memorial trees).
q. Electrical light fixtures.
r. Electrical equipment.
s. Starters.
t. Windows.
u. Transformers.
v. Thermostats.
w. Shelving.
x. HVAC mixing boxes.

F. Prior to finalizing the Construction Documents, the DP shall conduct a site meeting with the appropriate Capital Programs Management Group personnel and determine precisely what items are to be salvaged. The documents should then clearly identify what is to be salvaged, by whom and where it is to be delivered to or stored. Option include, but are not limited to:

1. Removal and transport by contractor.

2. Removal by contractor and transport by the owner.

3. Removal and transport by the owner.

4. Transportation destinations include the Capital Programs Management Group compound, Surplus Property Department, or any other other location determined during the site meeting.

G. Whenever ASU is to participate in either the removal or transportation of salvage materials, the time frame and contact person shall be identified and referenced in the documents.

H. All items encountered which contain an affixed Arizona State University control tag ("A" tag) require special procedures for disposal. Consequently, these items should be brought to the attention of Capital Programs Management Group. Items which contain an "A" tag are part of the registered inventory of a particular Arizona State University department or unit and disposal must be coordinated through their respective business manager.

I. The scope of the demolition plan should be carefully reviewed and coordinated with Environmental Health and Safety to ascertain the existence of any hazardous materials requiring special attention. Most laboratory equipment will require decontamination before demolition and/or removal, i.e. fume hoods, laminar flow enclosures, clean benches, biological safety cabinets, etc.

J. Fluorescent light fixture tubes and certain light fixture ballasts must be separately disposed of in accordance with applicable environmental regulations. Consequently, the removal and disposal of existing fluorescent light fixtures shall
include the following:

1. All fluorescent tubes shall be removed and packaged by the Contractor in cartons supplied by the ASU Electric Shop. The number of tubes in each carton shall be clearly marked on the outside of the carton. Contractor to deliver packaged tubes to the ASU Electric Shop for disposal.

2. Fixture ballasts not clearly marked as containing "No PCB's" shall be removed by the Contractor and after short clipping all wires place them in a metal drum supplied to the jobsite by Arizona State University Environmental Health and Safety. After completion of the demolition effort, Arizona State University Environmental Health and Safety will remove the drum for disposal offsite. Apportioned disposal costs are then to be charged to the project.

K. All electrical services discontinued with the demolition effort shall be properly "tagged out."

L. Because all facilities within Arizona State University are classified as NESHAP facilities, the regulatory requirements of the Maricopa Country Department of Environmental Quality apply to all demolition projects. Consult with Environmental Health and Safety to determine the exact requirements. All permits and fees for demolition are the responsibility of the Contractor, but these requirements should be specifically identified in the Contract Documents.

M. For renovation of building elements with existing lead paint or other materials requiring abatement: If possible, complete removal and replacement of building elements may be less expensive and time consuming than the abatement of existing building elements containing lead paint or other materials that typically require abatement. In particular, existing historical windows may have sash painted with lead paint and it may be less costly to construct new sash to match the existing (within historic building guidelines) than to sand and fill existing sash. DP should consult with Capital Programs Management Group regarding past experiences regarding the use of abatement versus replacement.
DIVISION 03 - CONCRETE

03 31 00  STRUCTURAL CONCRETE

Description

Structural concrete drawings shall be coordinated between the various sub consultants to avoid field problems with openings, shear walls, and structural slabs. Drawings shall show special reinforcement required at openings. Drawings shall show location of construction, expansion, and contraction joints. ACI references shall be comprehensive to cover the requirements needed. Testing per section 01 45 29

Design Standard

A. Mock-ups should be required for any structural concrete that is to receive a finish treatment such as a sandblasted, exposed aggregate, or bush hammered finish. Special finishes shall be specified in section 03 45 00 Architectural Concrete or section 03 35 23 Exposed Aggregate Concrete. Mock-ups shall not be incorporated into the final work.

B. Testing shall be done to most current ASTM standards.

C. Minimum concrete compressive strength shall be 3000 psi. Provide a detailed concrete mix schedule if more than one strength or type of concrete is required for the project.

D. Specify the type of formwork required for each type of pour. Wood forms shall be limited to three uses. Consider the joint placement on formwork that will result in exposed concrete. Fiberglass grip form ties shall not be allowed.

E. Vapor retarder or moisture barrier shall be required for all below grade work.

F. Curing compounds and form release agents shall be non-staining and compatible with the wall and floor finishes specified.

G. Penetrating sealers on exposed interior concrete floors shall be compatible with Waxie “Floorstar” products. Sealer or finish should be applied immediately after the dissipation of the curing compound in order to protect floors during construction and then cleaned and reapplied prior to final acceptance.

H. Column penetrations through slabs shall be initially blocked out in a diamond shape and infilled afterwards.

I. Slabs shall be depressed (dished) ½” deep around all floor drains for a minimum radius of 3'-0”.

J. Sealed concrete: Prior to application of sealer, floors shall be cleaned with a “side by side” machine, wet vacuum and rinsed.
03 35 23   EXPOSED AGGREGATE CONCRETE

Description

Design Standard

A. All walks shall receive exposed aggregate borders 12" minimum wide on either side of the walk or 4" by 4" exposed aggregate curbing on both sides. Any border between 12" wide and 24" wide requires mechanical connections to the adjacent walks. Any exposed aggregate curbs used require mechanical connections to the walks.

B. All exposed aggregate borders or exposed aggregate curbing shall be washed gravel, minimum exposed height of 1/4" and be hand seeded in concrete.

C. The finish shall be medium retarded water washed, followed by a brushed acid washing after curing.

D. Black color add-mix, 20 lbs. per c.y. In the event that the DP has compelling design rationale for the use of color other than listed above, they shall submit a composite sample, 1’ by 1’ illustrating the proposed color, to the variance committee for approval prior to the completion of the schematic design phase of the project.

E. Steps, platforms, landings or any elevation change in the walk path in excess of 1-1/2", not sloped to meet ADA requirements, shall receive exposed aggregate strips of 12" minimum in width, one strip at the start of the change and one strip at the end to indicate the elevation change.

F. Planters, benches, etc., that are located within the walk shall receive either the exposed aggregate border or exposed aggregate curbing.

G. All planter beds, all changes in elevation greater than 1-1/2” adjacent to walks shall receive exposed aggregate borders or curbing.

H. Any deviation to this standard requires a variance from the variance committee.

03 45 00   ARCHITECTURAL PRECAST CONCRETE

Description

This section applies to areas of a building that the DP may be considering for the use of precast panels, or special design features or projection from and around the building, that will be visible.

Design Standard

A. Color, finish and scoring shall be clearly delineated either by a sample or a drawing of a scale that can be viewed across a conference room. Elevations that contain precast material or features shall be keyed to such a sample or drawing.
B. Precast in-fill panels, elements or exposed precast structural members shall be designed and detail in a manner that clearly and concisely conveys the architectural meaning and significance of its use.

C. Rough or heavy textured precast should be avoided immediately adjacent to heavy pedestrian traffic flow, or in the interior of the building (particularly corridors).

D. Precast concrete panels shall be water sealed with products warranted for a minimum of five years against UV breakdown.

E. Exposed panel fastening devices should be avoided due to annual maintenance costs (paint and rust inhibitors) and eventual staining of the panel.

F. Special consideration should be given to panel joinery and caulking when panels are intended to act as a weather tight assemblies. The design of such joinery must facilitate required amounts of expansion/contraction and facilitate a neat appearance and weather tightness of the caulk joint.
DIVISION 04 - MASONRY

04 05 15 MASONRY & MORTAR

Description

The intent of this section is to raise special concern regarding the tendency for low cost design in detailing and specifications of masonry claddings and features brought about by budgetary pressures. Every effort should be taken by the DP to properly specify and detail masonry veneers, applications, joints and fastening systems to protect against moisture infiltration, efflorescences, cracking caused by improper structural back-up materials and excessive maintenance. The DP should pay special attention to the fact that the owner's intent is to construct buildings that are permanent structures, i.e., have a useful lifetime of approximately 50 years. A low cost design approach in areas that cannot be "seen" undermines the philosophy of building at ASU, and in the end, are usually much more costly in remedial corrective action.

Design Standard


B. Sand: conforming to ASTM C144.

C. Brick: conforming to ASTM C216, Grade SW, Type FBX. ASTM C67, compressive strength 3,000 psi, no efflorescence. Color, size and texture: similar to the predominant brick material on Campus, generally conforming to No. 833 M2 Blend as produced by El Paso Brick, size 2 1/4 inch x 3 5/8 inch x 7 5/8 inch. To minimize brick color variations, the project should be fired and supplied in one continuous run. If variations in color exist within the run, the differently shaded bricks may be randomly intermixed as the wall is constructed. Obvious delineations in the brick color will not be acceptable.

D. Horizontal wire reinforcing: No.9 gauge wire, Class 1 mill galvanized.

E. Veneer back-up: 8 inch wide concrete masonry units, or structural steel studs with a 3/4 inch substrate (equal or better than "Wonderboard").

F. Sealer: waterproofing sealer, guaranteed performance minimum 5 years from UV breakdown.

G. Control & expansion joints: 20' minimum in run.

H. Flashing: through-wall concealed flashing at all shelf angles, lintels, ledges and other obstructions to downward flow of moisture within the wall.

I. Cap: The tops of all masonry walls shall receive a watertight cap, i.e., sheetmetal or precast concrete, to prohibit moisture infiltration and efflorescence.

J. Planters: completely lined with watertight fiberglass. Provide weep holes as
appropriate.

K. Weep Holes: polyethylene plastic tubing, 1/4 inch diameter x 4 inch long.

L. Workmanship:

1. For all new and infill masonry work adjacent to existing walls, require that a 3'-0" by 3'-0" mock up wall be constructed to ensure that both the brick and cured mortar colors are satisfactorily matched. Require a minimum of a 3 week curing time for evaluation of the mortar color.

2. On new construction a similarly appropriately sized mock up should be constructed to establish the standard acceptance for all elements of the work, i.e. mortar color, flashing, coursing, pattern, control joints, accessories, tolerances, etc.

3. Tolerances: Masonry work that does not conform to the following tolerances shall be repaired or replaced as directed by the Architect. Tolerances are based on actual dimensions.

   a. External corners and other conspicuous lines and levels: +/- 1/4 inch in any 10'-0" section.

   b. Line of sealant filled movement joints (allowable deviation from specified or indicated): +/- 3/8 inch in any 10'-0" section.

   c. Actual cross sectional dimension of columns and walls (allowable deviation from specified or indicated): - 1/4 inch, + 1/2 inch.

   d. Adjacent unit faces in plane (allowable deviation from specified or indicated): +/- 1/8 inch.

   e. Mortar bed joint thickness (allowable deviation from specified or indicated): -1/8 inch, +1/8 inch.

   f. Mortar head joint thickness (allowable deviation from specified or indicated): -1/8 inch, +1/4 inch.

   g. Vertical alignment of the centerline of corresponding head joints in alternate courses when using other than stack bond (allowable deviation from specified or indicated): +/- 3/8 inch.

   h. Vertical alignment of the centerline of all head joints in a total wall height not to exceed 30'-0" when using other than stack bond (allowable deviation from specified or indicated): +/- one inch.

   i. Vertical alignment of the centerline of all head joints in total wall height not to exceed 30'-0" when using stack bond: (allowable deviation from specified or indicated): +/- 1/2 inch.

4. The type of mortar joint should be specified. Tooled joints are preferred. Raked and flush joints are discouraged.
04 40 00  CUT STONE

Description

Usually the budget will preclude major use of cut stone as a veneer on projects, however as design detail elements (lintels, cornices, parapet caps, inlays, etc.) the same care in design and specification should be exercised by the DP as with brick masonry.

Design Standard


B. Sand: Conforming to ASTM C144.

C. Anchors: Conforming to latest edition of the IBC. All anchors shall be mechanically set, stainless steel.

D. Veneer back-up: 8 inch concrete masonry units where possible.

E. Type: Designer option, although native materials are encouraged (Arizona Sandstone).
DIVISION 05 - METALS

05 50 00   METAL FABRICATIONS

Description

This section applies to all metal fabrications that will be used by the DP that have a visual aesthetic impact both interior and exterior. Great care should always be exercised by the DP in the design and detailing of metal fabrication in that they strictly comply to all applicable codes, are relatively easy to construct and maintain (finishes) and do not create potential hazards due to inconsistent heights, surface textures, harsh protrusions or "blend" too well with adjacent surfaces or finishes that could create a special hazard to the visually impaired and physically handicapped.

Design Standard

Applicable Items: Rough Hardware, Ladders, Nosings, Trim, Pipe Railings, Stairs, Bollards and Architectural Features.

A. Welds should be smoothly ground to match surface texture of parent metal. All gaps, holes and gouges should be filled with a permanent material (solder or brazing). Design limitations of grinders, files, etc., dictate that adjoining metal tubing pieces at angles less than 125 degrees generally need a minimum of 1/4 inch radius butt weld in order to grind smooth.

B. Adjoining railing splices shall be fully concealed in runs that appear constant.

C. At elbow bends, the design should facilitate mitered joints.

D. Metal used for railings should be tube stock, not solid stock, and conform to ASTM A 500. Limiting unsupported length should not exceed 6'-0" for diameters 2 inches or less.

F. The use of expansion bolts to secure railing assemblies to vertical or horizontal surfaces is not allowable. Anchorage systems should consist of direct imbeds (sleeves or plates) and/or welding.

G. Exterior exposed metal fabrications shall have a spray applied epoxy-polymide type primer, with finish paint coat(s) as described in 09 91 00.

H. Interior exposed metal fabrications shall have spray applied epoxy-polymide type primer paint with finish paint as described in 09 91 00.

I. Ladders shall be a minimum width of 18 inches, 3/4 inch diameter rungs spaced 12 inches o.c., braced a minimum of 5'-0" o.c. Rungs should have a non-slip type finish.

J. All stair nosings shall have a permanently applied non-slip surface, either integral or imbedded, 2 inches wide minimum the width of the tread.

K. Where metal stair risers are exposed (not covered), they shall have have spray
applied epoxy-polymide type primer paint with finish paint as described in 09 91 00.

L. At the top and bottom of stair landings, a contrasting color and texture to the normal stair treads shall be used to facilitate the blind and visually impaired.

M. Expansion joints should be provided in continuous runs at a minimum interval of 40'-0".

N. All exposed to public fabrications with right angles corners shall be radiused a minimum of 1/8 inch.

O. Metal bollards shall be a minimum of 6 inches in diameter, round or square and be directly or sleeve set a minimum of 1/3 the exposed height below the finished adjacent surface.

P. Metal trim in continuous runs shall have concealed splices and be of sufficient gauge that natural distortions are not visually apparent. All exposed edges to the public shall be radiused or sharp edges eased.
DIVISION 06 - WOOD, PLASTICS & COMPOSITES

06 40 00 ARCHITECTURAL WOODWORK

Description

This section applies to architectural mill and casework. In general, the design and specification of items contained normally in this section must be considered to last the lifetime of the building. Flexibility, years of heavy use and misuse, limited maintenance, high impact, occasional overloading and initial cost effectiveness should be the criteria in the design and finish.

Design Standard

A. Endangered or limited tree species used as veneers or solid stock (mahogany, teak, etc.) are not allowable. Soft species used for face veneers, tops, kick plates, bases or any other high impact or abrasion related use are not allowable.

B. Wood thresholds are not acceptable.

C. Millwork and Casework

1. Case or millwork that will be specified as receiving a painted finish, should be limited to lower cost species (birch, poplar, etc.).

2. All cabinet and millwork tops, sides, dividers, etc., shall be 3/4 inch minimum stock. Stained veneer materials shall conform to AWI custom grade, minimum thickness 1/16 inch. Architectural Woodwood Institute (AWI) publications are available at: http://www.awinet.org/.

3. Unexposed framing shall be nominal 1 x 2 hardwood, AWI custom grade.

4. Doors and drawer fronts shall be 3/4 inch minimum core stock.

5. Drawer boxes shall be 1/2 inch minimum plywood such as Baltic Birch with a minimum 1/4" plywood bottoms.

6. Synthetic counter tops should be equal to "Corian," 5/8 inch minimum thickness.

7. Cabinet tops should be of sufficient height to comply with minimum handicap accessibility requirements.

8. Built-in shelving or free standing modular shelving height should not exceed 84" from finished floor (unless used in large storage areas) and be securely anchored to studs that are reinforced to accept the loading or to unit masonry walls.

9. All shelving should be designed as fully adjustable, 3/4 inch minimum thickness.

10. "Line bore and pin" to be acceptable with a minimum of 1" adjustments.

11. All millwork and accessory hardware shall comply with ANSI A156.9,
minimum quality level Type 2 (institutional). Hinges, guides, slides, etc., shall utilize bearings complying with BHMA 201.

12. All cabinet hinges should be concealed and self closing.

13. Drawer slides should allow full extension (1 inch longer than total drawer depth) and be specified as heavy duty (100 lb. minimum).

14. The use of painted particleboard as the finish for cabinets and tops is not acceptable. Particle board is allowable as core stock in low/no moisture areas when receiving a high pressure plastic laminate finish.

15. Particle board is not an acceptable material for shelving with greater than a 2’ unsupported span.

16. The use of melamine or other similar low mill finishes (less than 0.020 inch) as interior cabinet lining or underside of shelving is acceptable in low to no moisture areas only.

17. Guides for plastic laminate finishing are as follows: min. 0.050 inch exposed horizontal surfaces; min. 0.028 inch exposed vertical surfaces; min. 0.020 inch cabinet linings and concealed backing.

18. The use of plastic laminate tops and splashes is not recommended for high moisture areas such as lav tops, coffee bar tops, or work surface that are repeatedly subjected to spillage, water cleaning, or subject to chemical substances.

19. All exposed cabinet hardware should be specified with a permanent, durable finish that is easily cleanable.

20. All countertops designed as work surfaces shall be of an appropriate height to accommodate the physically handicapped.

21. All millwork designed to support electrical equipment (computers, phones, clocks, etc.) shall have grommet openings allowing cords, interconnect cable, etc, to be concealed or routed internally. Grommets shall be 2-2-3/8 minimum diameter plastic, color to match adjacent finish.

22. Any construction, building addition or alteration project which is financed by monies of this state or its political subdivisions shall not use endangered tropical hardwood unless an exemption is granted by the director of the department of administration. The director shall only grant an exemption if the use of endangered tropical hardwood is deemed necessary for historical restoration or to repair existing facilities and the use of any substitute material is not practical. Any lease-purchase agreement entered into by this state or its political subdivisions for construction shall specify that no endangered tropical hardwood may be used in the construction unless an exemption is granted by the director. As used in this subsection, "endangered tropical hardwood" includes ebony, lauan, mahogany, or teak hardwood.

23. Floors and walls that will be concealed by casework shall be cleaned prior to installation of the casework.
DIVISION 07 - THERMAL & MOISTURE PROTECTION

07 00 00 GENERAL DISCUSSION

Introduction

This section will specify materials which are critical to design of successful moisture protection systems in new construction and renovation, but which are not the sole responsibility of any individual trade. In many cases, the issues involved are fundamental to the basic design of the project, and the success or failure of the moisture protection systems are determined at the very outset of the design process.

ASU at the Tempe campus is geologically placed over a dry river bed. Impermeable moisture barriers are required for all below grade slabs. Foundation drainage systems, dampproofing and/or waterproofing are required at all below grade walls, including foundation walls.

The 2 types of roofing material described in this division are: 1) membrane (built-up) roofing, and 2) SBS-Modified Bituminous Membrane Roofing. ASU at the West campus has historically used Thermo or hypalon roofing systems. The DP is not prohibited from using other roofing systems, however, coated foam roofing (PUF or SPF) is not acceptable. The use of other roofing materials (modified bitumen and single ply) should take into consideration the amount of foot traffic (from maintenance personnel) that may occur on the roof. The quality and warranty standards set forth for membrane roofing should be used as minimum performance standards for any other roofing systems.

The installation of asbestos containing material (ACM) is prohibited. In instances where new or remodeled construction comes into contact with previously abated ACM, specify only materials which are known to be compatible with asbestos encapsulants.

07 13 00 SHEET WATERPROOFING

Description

This section applies to sheet waterproofing of building components that receive or are in and around areas to receive such treatment. Proper architectural design and detailing of areas exposed to moisture should not rely solely on such treatments as the only barrier to moisture, but rather as a “guarantee” or “second line of defense,” in other words, the design and specification of appropriate materials should in itself greatly mitigate a majority of moisture infiltration problems.

Design Standard

A. The DP should attempt to specify primary waterproofing materials of each type from a single manufacturer.

B. The DP should review foreseeable methods and procedures relating to waterproofing materials early on (design development) with a considered manufacturer of the product(s) for insights and suggestions that could alter the approach in mind.
C. The DP should select a manufacturer(s) capable of providing a 5 year warranty on the material(s) being specified.

D. The DP should specify that before membranes on horizontal surfaces are covered by protection course(s) or other work, test for leaks with a 2 inch depth of water maintained for 48 hours be conducted by the contractor or subcontractor.

07 21 00 INSULATION

Description

This section applies to all constructed building vertical and horizontal surfaces that are thermal barriers to the environment and also inclusive of demising partitioning acting as acoustical barriers. ASU's goal for new projects is a substantial reduction in energy usage, both Campus wide and building specific. All effort should be focused to mitigate thermal and acoustical factors through proper architectural design, detailing, orientation and adjacencies, and utilize applied insulating materials as a further enhancement to the composite performance of the design rather than the sole means of obtaining the desired performance.

Design Standard

A. Roofs or other exposed horizontal surfaces shall attain a minimum composite R value of 30.

B. Exterior walls or other exposed vertical surfaces shall attain a minimum R value of 20.

C. Generally (unless noted otherwise), all corridor, restroom, classroom, laboratory, conference, meeting, lobby, and office walls and ceilings shall be fully sound attenuated.

D. Where blanket type insulation or sound attenuation material is being utilized in open plenum areas, it should be specified as being "kraft" or foil faced and backed (depending on installation).

E. Do not specify any form of insulation to be laid directly on accessible ceilings. Instead, detail horizontal insulation at the top of the cavity, and extend vertical insulation up to that level.

F. Specify mechanical attachment for all insulation. Do not specify insulation to be adhesive applied or installed loose.

07 24 00 EXTERIOR INSULATION & FINISH SYSTEMS

Description

This section applies primarily to exterior insulating and finish systems that would be considered as the "secondary" skin treatment to a building, soffits, mechanical screen
walls, infills, etc. The term "secondary" is used to indicate ASU's desire for brick masonry to be used as the "primary" skin material. A common trade name term that describes the system(s) covered under this section is "Dryvit" or other synthetic plaster applications over exterior insulation. Indicate all required expansion, control, and design joints on the project drawings.

Design Standard

A. Specify primary products as produced and supplied from a single manufacturer, which has produced that product successfully for not less than 5 years.

B. Specify that a single installer shall perform the work, and have not less than 5 years of successful experience in the installation of exterior insulating finish systems. Installer shall provide a 3'-0" x 3'-0" mock-up to demonstrate texture and color.

C. ASU will require a 5 year warranty on the system. Only those manufacturers that can comply with this warranty shall be specified.

D. Concrete masonry units are preferred as the back-up construction, however if budget and/or design considerations deem this inappropriate, fiberglass reinforced gypsum/portland cement ("Wonder board") panels, 3/4 inch thick, over structural steel studs is an acceptable substrate.

E. Composite panels of expanded polystyrene with a minimum composite R value of 20, shall be mechanically attached to the back-up system. Use only type “PM” mechanically attached systems.

F. The composite finish system shall consist of heavy duty glass fiber reinforcing (adjacent to any area of pedestrian traffic, to a height of 8’ above finish floor), synthetic elastomeric primus layer, minimum 3/8 inch thick and a elastomeric synthetic finish layer, minimum 1/16 inch thick.

07 51 00 BUILT-UP ROOFING SYSTEMS

Description

This section applies specifically to built-up roofs, but also pertains to other methods of roofing for those areas effectively acting as "roofs" (decks, overhangs, balconies, etc.). To aid in attaining both the written specification and warranties called for by ASU, the DP should design and detail appropriate roof slopes, drainage system(s), cants, flashing, protection devices or materials and utilize good common sense. Roofing techniques, systems and materials should be utilized that are "time proven" (+5 years) and be designed as "composite" systems instead of appliques. Roofing shall be done only by a roofer who is approved by the manufacturer whose materials are used.

Design Standard

A. Specify primary products, including roofing sheets, as produced and supplied from a single manufacturer, which has produced that product successfully for not less than 5 years.
B. Specify that a single installer shall perform the work, and have not less than 5 years of successful experience in the installation of built-up systems (or others if a different system is designed).

C. The DP should review the proposed roofing system early on (design development) with a considered manufacturer or installer of the system(s) for insights and suggestions that could alter the approach in mind.

D. ASU requires a 20 year limited service warranty on all built-up roofing systems. Only those manufacturer’s that can comply with this warranty should be specified.

E. Built-up roofing systems shall be 4 ply with a smooth white elastomeric or approved reflective finish coating, SBS top sheet preferred. Minimum 1/2 inch per foot slope to be built into the structure. Tapered insulation will not be accepted.

F. Roofing systems should be designed and/or specified that will allow occasional foot traffic by maintenance personal. In areas where there is a more frequent foot traffic, additional built-up walk or elevated pads should be designed and demarcated (TRAFBLOC material).

G. Exterior insulation systems on top of built-up layers should be avoided due to the extreme difficulty in tracing and repairing roofing leaks.

H. In general, built-up roofing systems with asphalt bitumen, glass fiber plys should be laid-up as follows:
   1) Base sheets on concrete should be heavyweight venting, consisting of asphalt coated fiberglass and spaced large mineral aggregate on bottom to allow vapor transmission. For base sheets on rigid insulation, a single ply of asphalt-impregnated glass-fiber mat, complying with ASTM D 2178, Type IV;
   2) 4 plies of asphalt-impregnated glass fiber mats, complying with ASTM D 2178, Type IV;
   3) white elastomeric or approved by Capital Programs Management Group,
   4) fibrated asphalt/clay emulsion coating, complying with ASTM D 1227, Type I, inorganic;
   5) fibrated reflective coating with asphalt cut back base, inorganic reinforcement, and leafing type, complying with ASTM D 2824, Type II.

I. Plastic or fiberglass roof drains and/or guards are not acceptable. Non ferrous metal(s) shall be specified.

J. Protection of installed material: Membrane roofing is a finish material, not a platform for further construction work. The following steps are required to protect the installed roof;
   1) If the contractor wants to “dry-in” the building early, provide a “Contractor’s Option” to provide a temporary roof or construction platform for completing work accomplished from or above the finished roof.
2) Reference the National Roofing Contractor’s Association requirements for temporary roofs.
3) Specifically prohibit “phased roofing” or patches in new roofing.
4) Require that finished roofs be protected with plywood sheets for any and all construction traffic, and that all equipment moving be accomplished with rollers.

07 52 16 SBS-MODIFIED BITUMINOUS MEMBRANE ROOFING

Description

This section applies specifically to SBS-modified bituminous membrane roofing.

The applicable portions of 07 51 00, Built-Up Roofing Systems that pertains to other methods of roofing for those areas effectively acting as “roofs” (decks, overhangs, balconies, etc.) shall apply to this section.

Design Standard

A. In addition to the 20 year limited service warranty required in 07 51 00, Built-Up Roofing Systems, a Contractor’s Warranty meeting the following requirements shall be provided:

1) The Contractor shall Warranty the installation of the roofing, flashing and all appurtenances to be watertight for a period of five (5) years from the date of Substantial Completion of the roofing project.
2) The Contractor shall make all repairs during the period of guarantee to maintain the roof watertight and in conformance with these specifications without additional cost to the Owner. If damage is caused during this period of Warranty by someone or something not related to the workmanship of the Contractor, said damage will be repaired on a time/material/profit basis.
3) At the end of the Warranty period, the Contractor shall at the Owner’s option and with a representative of the Owner, conduct a final inspection. The Contractor at his expense shall repair all blisters, bubbles, bare spots and other defects visible. The Owner has the right, in the case of an emergency at any time during the period of the Warranty, and without invalidating this Warranty, to make any temporary repairs that are required in order to protect the building and the contents of the building from damage due to the roof leaking.
4) Owner’s Rights: The Warranty shall not deprive the Owner of other rights the Owner may have under other provisions of the Contract Documents and will be in addition to and run concurrent with other warranties made by the Contractor under requirements of the Contract Documents.

B. SBS roofing systems shall be a 3 ply (base, ply and surface sheet) with Energy Star Labeled coating with minimum emittance of 0.9 over a polyisocyanurate board roof insulation.

1) Polyisocyanurate board insulation shall conform to ASTM C 1289, Type II with felt or glass-fiber mat facer on both sides. First layer of insulation shall be mechanically fastened to meet requirements of FMG’s “Approval Guide.”
2) **Base Sheet:** Single sheet of glass-fiber mat coated on both sides with roofing grade asphalt 25 lb. per 100 square feet minimum +/- 10%. UL classified G-2 base sheet.

3) **Ply Sheet:** Two plies of asphalt coated glass-fiber mat, coated on both sides with styrene butadiene styrene modified asphalt. Material thickness 90 mils + 10%, ASTM D 6163, Weight per 100 sq. ft. - 63.33 lbs.

4) **Roofing Membrane Cap Sheet (Surface Sheet):** Single sheet of 250 g/m2 polyester mat coated on both sides with a fire retardant styrene butadiene styrene modified asphalt, with the top surface covered with ceramic granules and the bottom surface covered with a fine mineral parting agent, 160 mils + 10% thickness, 113 lbs. per 100 sq. ft. minimum, ASTM D 6163.
   a) Flashing sheet for heights over 12 inches above roof surface shall be as recommended by manufacturer.
   b) Flashing sheets shall extend a minimum of 18 inches onto the horizontal field of roof.
   c) Granule Color: White.

5) **Flash Sheet:** Single plies of fiberglass coated on both sides with styrene butadiene styrene modified asphalt, with the top surface covered with ceramic granules and the bottom surface covered with a fine mineral parting agent, 150 mils + 10% thickness, 100 lbs. per 100 sq. ft. minimum, ASTM D 6163.
   a) Flashing sheet for heights over 12 inches above roof surface shall be as recommended by manufacturer.
   b) Flashing sheets shall extend a minimum of 18 inches onto the horizontal field of roof.
   c) Granule Color: White.

6) **Roof coating:** Energy Star Labeled, ASTM D6083, acrylic elastomer emulsion coating, formulated for use on bituminous roof surfaces.
   a) Color: White.
   b) Emittance: At least 0.9 when tested in accordance with ASTM E 408.
   c) Thickness: 35 mils, dry film.

C. **FMG Listing:** Roofing membrane, base flashings, and component materials shall comply with requirements in FMG 4450 and FMG 4470 as part of a roofing system and shall be listed in FMG’s "Approval Guide" for Class 1 or noncombustible construction, as applicable. Materials used shall be identified with FMG markings. Fire/Windstorm Classification shall be Class 1A-90 and Hail Resistance shall be MH.

D. Samples for verification shall be provided to the owner prior to installation for the following products:

1) 12-by-12-inch (300-by-300-mm) square of base sheet and ply sheet.
2) 12-by-12-inch (300-by-300-mm) square of mineral-granule-surfaced roofing membrane cap sheet and flashing sheet, of color specified.
3) 12-by-12-inch (300-by-300-mm) square of roof insulation.
4) 12-by-12-inch (300-by-300-mm) square of walkway cap sheet.
5) Six insulation fasteners of each type, length, and finish.

**07 84 00 FIRESTOPPING**

**07 84 01 RELATED DOCUMENTS**

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and the CMAR Operating Manual, apply to work specified in this section.
ASU Design Guidelines Section II

07 84 02 DEFINITIONS

A. Firestopping: Material or combination of materials used to retain integrity of fire-rated construction by maintaining an effective barrier against the spread of flame, smoke, and hot gases through penetrations in, or construction joints between, fire rated wall and floor assemblies.

07 84 03 GENERAL DESCRIPTION OF THE WORK OF THIS SECTION

Only tested firestop systems shall be used in specific locations as follows:

A. Penetrations for the passage of duct, cable, cable tray, conduit, piping, electrical busways and raceways through fire-rated vertical barriers (walls and partitions), horizontal barriers (floor/ceiling assemblies), and vertical service shaft walls and partitions.

B. Safing slot gaps between edge of floor slabs and curtain walls.

C. Openings between structurally separate sections of wall or floors.

D. Gaps between the top of walls and ceilings or roof assemblies.

E. Expansion joints in walls and floors.

F. Openings and penetrations in fire-rated partitions or walls containing fire doors.

G. Openings around structural members which penetrate floors or walls.

07 84 04 RELATED WORK OF OTHER SECTIONS

A. Coordinate work of this section with work of other sections as required to properly execute the work and as necessary to maintain satisfactory progress of the work of other sections, including:

1. Section 03300 - Cast-In-Place Concrete
2. Section 07900 - Joint Sealers
3. Section 04200 - Masonry Work
4. Section 09200 - Lath and Plaster
5. Section 09250 - Gypsum Drywall Systems
6. Section 13080 - Sound, Vibration and Seismic Control
7. Section 13900 - Fire Suppression and Supervisory Systems
8. Section 15050 - Basic Mechanical Materials and Methods
9. Section 15250 - Mechanical Insulation
10. Section 15300 - Fire Protection
11. Section 15400 - Plumbing
12. Section 16050 - Basic Electrical Materials and Methods

07 84 05 REFERENCES

II - 21
REVISED MARCH 2010
A. Test Requirements: ASTM E 814, "Standard Method of Fire Tests of Through Penetration Fire Stops"

B. Test Requirements: UL 1479, “Fire Tests of Through-Penetration Firestops”


D. Underwriters Laboratories (UL) of Northbrook, IL publishes tested systems in their annually-updated "FIRE RESISTANCE DIRECTORY".

1. UL Fire Resistance Directory:
   a. Firestop Devices (XHJI)
   b. Fire Resistance Ratings (BXRH)
   c. Through-Penetration Firestop Systems (XHEZ)
   d. Fill, Voids, or Cavity Material (XHHW)
   e. Forming Materials (XHKU)
   f. Joint Systems (XHBN)
   g. Perimeter Fire Containment Systems (XHDG)


J. International Firestop Council Guidelines for Evaluating Firestop Systems Engineering Judgments

K. International Building Code


M. NFPA 70 - National Electric Code
## THROUGH-PENETRATION UL CLASSIFICATION SYSTEM

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<tr>
<td>1 No Penetrating Items:</td>
<td>F, W, C</td>
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<td>2 Metallic Pipes, Conduit or Tubing:</td>
<td>F, W, C</td>
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**Construction Penetration**
- **F** Floor penetration
- **W** Wall penetration
- **C** Either floor or wall penetration

**Type of Construction**
- **A** Concrete floors equal to or less than 5-inches thick
- **B** Concrete floors greater than 5-inches thick
- **J** Concrete or masonry walls equal to or less than 8-inches thick
- **K** Concrete of masonry walls greater than 8-inches thick
- **L** Framed walls

## JOINT UL CLASSIFICATION SYSTEM

<table>
<thead>
<tr>
<th>Fire-Resistant Joint Systems</th>
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<td><strong>Joint System</strong></td>
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| 1 Floor-to-Floor             | FF D                      |
| 2 Wall-to-Wall               | WW D                      |
| 3 Floor-to-Wall:             | FW D                      |
| 4 Head of Wall:              | HW D                      |

**Movement Capability**
- **D** Dynamic Has movement capability
- **S** Static Has no movement capability

**Joint Width**
- 0000-0999 Less than or equal to 2”
- 1000-1999 Greater than 2” Less than or equal to 6”
- 2000-2999 Greater than 6” Less than or equal to 12”
07 84 06  QUALITY ASSURANCE

A. Fire-Test-Response Characteristics: Provide through-penetration firestop systems and fire-resistive joint systems that comply with specified requirements of tested systems.

B. Firestop system installation must meet requirements of ASTM E 814, UL 1479 or UL 2079 tested assemblies that provide a fire rating equal to that of construction being penetrated.

C. Proposed firestop materials and methods shall conform to applicable governing codes having local jurisdiction.

D. Firestop systems do not reestablish the structural integrity of load bearing partitions/assemblies, or support live loads and traffic. Installer shall consult the structural engineer prior to penetrating any load bearing assembly.

E. For those firestop applications that exist for which no qualified tested system is available through a manufacturer, an engineering judgment derived from similar qualified tested system designs or other tests will be submitted to local authorities having jurisdiction for their review and approval prior to installation. Engineering judgment documents must follow requirements set for

07 84 07  SUBMITTALS

A. Submit Product Data: Manufacturer's specifications and technical data for each material including the composition and limitations, documentation of qualified tested firestop systems to be used and manufacturer's installation instructions to comply with Section 1300.

B. Manufacturer's engineering judgment identification number and document details when no qualified tested system is available for an application. Engineering judgment must include both project name and contractor's name who will install firestop system as described in document.

C. Submit material safety data sheets and certificates of compliance provided with product delivered to job-site.

D. VOC Content Limitations: For firestop system products, submit documentation of conformance with LEED EQ Credit 4.1 “Low-Emitting Materials, Adhesives, and Sealants.”

07 84 08  INSTALLER QUALIFICATIONS

A. Installers must be experienced, certified, licensed, or otherwise qualified by the firestopping manufacturer as having been provided the necessary training to install manufacturer's products per specified requirements. A supplier's willingness to sell its firestopping products to the Contractor or to an Installer engaged by the Contractor does not in itself confer qualification on the buyer.
B. Installation Responsibility: assign installation of through-penetration firestop systems and fire-resistive joint systems in project to a single sole source firestop specialty contractor.

C. The work is to be installed by a contractor with at least one of the following qualifications:

- Hilti Accredited Fire Stop Specialty Contractor (HAFSC)
- 3M “Master Contractor”
- Hilti “Certified Contractor” with current letter from manufacturer
- 3M “Certified Contractor” with current letter from manufacturer
- UL Approved Contractor
- FM 4991 Approved Contractor

D. Installing firm must not have less than 3 years experience with fire stop installation.

E. Installing firm must have successfully completed not less than 3 comparable scale projects using similar systems.

07 84 09 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials undamaged in manufacturer’s clearly labeled, unopened containers, identified with brand, type, and UL label where applicable.

B. Coordinate delivery of materials with scheduled installation date to allow minimum storage time at job-site.

C. Store materials under cover and protect from weather and damage in compliance with manufacturer’s requirements, including temperature restrictions.

D. Comply with recommended procedures, precautions or remedies described in material safety data sheets as applicable.

E. Do not use damaged or expired materials.

07 84 10 PROJECT CONDITIONS

A. Do not use materials that contain flammable solvents.

B. Schedule installation of firestopping after completion of penetrating item installation but prior to covering or concealing of openings.

C. Verify existing conditions and substrates before starting work. Correct unsatisfactory conditions before proceeding.

D. Weather conditions: Do not proceed with installation of firestop materials when temperatures exceed the manufacturer’s recommended limitations for installation printed on product label and product data sheet.
E. During installation, provide masking and drop cloths to prevent firestopping materials from contaminating any adjacent surfaces.

07 85 00 FIRESTOPPING PRODUCTS

07 85 01 FIRESTOPPING, GENERAL

A. Provide firestopping composed of components that are compatible with each other, the substrates forming openings, and the items, if any, penetrating the firestopping under conditions of service and application, as demonstrated by the firestopping manufacturer based on testing and field experience.

B. Provide components for each firestopping system that are needed to install fill material. Use only components specified by the firestopping manufacturer and approved by the qualified testing agency for the designated fire-resistance-rated systems.

C. Firestopping Materials are either “cast-in-place” (integral with concrete placement) or “post installed.” Provide cast-in-place firestop devices prior to concrete placement.

07 85 02 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with through penetration firestop systems (XHEZ), joint systems (XHBN), and perimeter firestop systems (XHDG) listed in Volume 2 of the UL Fire Resistance Directory; provide products of the following manufacturers as identified below:

1. Hilti, Inc., Tulsa, Oklahoma
   800-879-8000/www.us.hilti.com

2. 3M Company, St. Paul, Minnesota
   800-328-1687/www.3m.com/firestop

3. Provide products from the above acceptable manufacturers; no substitutions will be accepted.

07 85 03 MATERIALS

A. Use only firestop products that have been UL 1479, ASTM E 814 or UL 2079, ASTM E 1966 tested for specific fire-rated construction conditions conforming to construction assembly type, penetrating item type, annular space requirements, and fire-rating involved for each separate instance.

07 86 00 - FIRESTOPPING EXECUTION

07 86 01 PREPARATION

A. Verification of Conditions: Examine areas and conditions under which work
is to be performed and identify conditions detrimental to proper or timely completion.

1. Verify penetrations are properly sized and in suitable condition for application of materials.

2. Surfaces to which firestop materials will be applied shall be free of dirt, grease, oil, rust, laitance, release agents, water repellents, and any other substances that may affect proper adhesion.

3. Provide masking and temporary covering to prevent soiling of adjacent surfaces by firestopping materials.

4. Comply with manufacturer's recommendations for temperature and humidity conditions before, during and after installation of firestopping.

3. Do not proceed until unsatisfactory conditions have been corrected.

07 86 02 COORDINATION

A. Coordinate construction of openings, penetrations and construction joints to ensure that the fire stop systems are installed according to specified requirements.

B. Coordinate sizing of sleeves, openings, core-drilled holes, or cut openings to accommodate through-penetration fire stop systems. Coordinate construction and sizing of joints to ensure that fire-resistive joint systems are installed according to specified requirements.

C. Coordinate fire stopping with other trades so that obstructions are not placed in the way prior to the installation of the fire stop systems.

D. Do not cover up through-penetration fire stop and joint system installations that will become concealed behind other construction until each installation has been examined by the building inspector, per requirements of Section 109, IBC 2000.

07 86 03 INSTALLATION

A. Regulatory Requirements: Install firestop materials in accordance with UL Fire Resistance Directory or Omega Point Laboratories Directory.

B. Manufacturer's Instructions: Comply with manufacturer's instructions for installation of through-penetration and construction joint materials.

1. Seal all holes or voids made by penetrations to ensure an air and water resistant seal.

2. Consult with mechanical engineer, project manager, and damper manufacturer prior to installation of UL firestop systems that might
hamper the performance of fire dampers as it pertains to duct work.

3. Protect materials from damage on surfaces subjected to traffic.

07 86 04 FIELD QUALITY CONTROL

A. Examine sealed penetration areas to ensure proper installation before concealing or enclosing areas.

B. Keep areas of work accessible until inspection by applicable code authorities.

C. Inspection of through-penetration firestopping shall be performed in accordance with ASTM E 2174, “Standard Practice for On-Site Inspection of Installed Fire Stops” or other recognized standard.

D. Perform under this section patching and repairing of firestopping caused by cutting or penetrating of existing firestop systems already installed by other trades.

E. Product Manufacturer’s Field Services Duties: During Installation, provide periodic destructive testing inspections to assure proper installation/application. After installation is complete, submit findings in writing indicating whether or not the installation of the tested system identified was installed correctly to both the general contractor and the Authority Having Jurisdiction.

07 86 05 ADJUSTING AND CLEANING

A. Remove equipment, materials and debris, leaving area in undamaged, clean condition.

B. Clean all surfaces adjacent to sealed holes and joints to be free of excess firestop materials and soiling as work progresses.

07 87 00 - LABOR INSTALLING FIRESTOP SYSTEMS

To ensure complete harmony on the project site, the installation of each scope of work is to be performed jurisdictionally correct per existing trade agreements

07 90 00 SEALANTS

Description

This section describes all requirements for sealants to prohibit the penetration of moisture and dust, and required to seal joints between dissimilar materials. Specify certain specialized sealants which are ordinarily part of a “complete in place” installation by a particular trade (i.e. glazing sealants, painting) in the appropriate sections. Reliance on trades to provide appropriate caulking or notes such as “sealant as required” are not acceptable.
Design Standard

A. Use a performance specification for required sealants. Do not specify proprietary manufacturer’s names or materials. Do not restrict vendors to a limited list.

B. Specify primary products, as produced and supplied from a single manufacturer, which has produced that product successfully for not less than 5 years.

C. Specify that an approved manufacturer’s installer shall perform the work, and have not less than 5 years of successful experience in the installation of caulks and sealants.

D. Provide a submittal requirement for product compliance, color selection, and samples of sealants used in applicable unique joint conditions.

E. Maximum allowable exterior joint width, for caulking/sealant, shall not exceed 1”.
DIVISION 08 - OPENINGS

08 11 00   HOLLOW METAL DOORS AND FRAMES

Description

This section applies to both interior and exterior applications. In general, hollow metal doors should be designed and specified for areas of heavy use and potential abuse. Commercial heavy duty hollow metal frames should be utilized regardless of whether the door be hollow metal, glass, or wood. Knock-down frames are not allowed. Double door systems shall have a removable center mullion.

Wood doors with hollow metal frames are preferred for interior applications at the ASU at the Polytechnic campus.

Design Standard

A. Doors and frames shall be specified as commercial heavy duty quality. Minimum door thickness shall be 1 3/4 inch thick. Interior doors shall comply with SDI-100, Grade II, heavy duty, minimum 18 gauge faces. Exterior doors shall comply with SDI-100 Grade III, extra heavy duty, minimum 16 gauge faces.

B. Where doors are to be used as part of an acoustical barrier assembly, they shall be rated a minimum of STC 33.

C. Doors used as a normal means of ingress and egress shall have either vision panels or adjacent sidelights (where allowable by fire ratings).

D. Doors and frames shall have a spray applied finish as described in 09 91 00.

E. Frames shall have wall anchors a minimum of 16 inch o.c. per jamb.

F. Doors shall carry a life of installation warranty from the manufacturer.

G. Maximum door height shall not exceed 7'-0". Minimum door width shall be 3'-0".

H. Designs calling for exterior glazed openings in steel doors, shall use 1 inch insulated wire glass. Openings shall be limited to less than 60% glass area (code permitting).

I. Timely door frames may be used at interiors, however, hollow metal door frames are required whenever door closers are required.

J. Building floor planning (location and swing of doors, etc.) shall allow for wall space as may be required to comply with ADA requirements.
08 11 16  ALUMINUM DOOR AND FRAMES

Description

This section applies to exterior and interior applications as approved by ASU in lieu of hollow metal doors and frames. Double door systems shall have a removable center mullion.

Design Standard

A. Doors shall be wide stile (minimum 5 inches) with 10 inch minimum bottom rail and 6 inch minimum top rails.

B. Materials: Doors and framing sections shall be of extruded aluminum alloy and temper to meet or exceed finishing and structural criteria as specified. Doors stiles and rails, excluding glass stops, shall be tubular and have wall thickness 0.125 inches or greater. Weathering shall be a hardbacked silicone treated polypropylene. Exposed fasteners shall be aluminum or stainless steel providing the steel is isolated from the aluminum, or other non-corrosive material.

C. Finish: Exposed surfaces shall be free of unsightly scratches and blemishes. The exposed sections shall receive a caustic etch followed by an anodized coating. Color shall be clear, unless otherwise specified. Finish with an architectural class anodic coating.

D. Construction and Design: Door stiles and rails shall be accurately joined at corners with heavy concealed reinforcement brackets secured with bolts and screws, and shall be MIG welded. Doors shall have snap-in stops with bulb glazing vinyl on both sides of the glass. No exposed screws shall be permitted. Each door leaf shall be equipped with an adjusting mechanism located in the top rail near the lock stile which provides for minor clearance adjustments after installation. Weathering shall be installed in the hinge stiles of pairs or single center hung doors. The lock stile of a single center hung door, active meeting stiles at a pair of butt hng, offset pivot, or center hung doors shall have an adjustable atragal weatherstrip. Door frame and sidelight framing shall be accurately joined at corners with unexposed screws. Glazing shall be flush, including the horizontal muntins and sills and held in place with E.P.D.M. glazing gaskets on boths sides. No applied stops shall be permitted except at the transom bar of center hung doors. Butt-hung and offset pivot door frames shall have doors stops at jambs and head with continuous weathering.

E. Custom Hardware: Doors shall be hung with 3 Stanley FBB179 NRP 26D or equal butts. Pairs of doors shall have a Von Duprin KR4954 removable mullion. Doors shall be prepped for Von Duprin series 99NL rim device. Doors receiving keyed cylinders shall have an exterior trim 99NL. Doors without keyed cylinders shall have an exterior trim 99DT. Von Duprin Series 99NL rim device and trim to be furnished by Owner and installed by Contractor. Doors shall be installed with a Norton 7500 or LCN 4040 door closer (except where an existing HDCP had been installed). Threshold
(where required) shall meet ADA specification. At existing locations, remove recessed floor or jamb mounted closures and patch the frame or concrete prior to installation of the threshold or frame mounted hardware.

F. Erection: Openings shall be prepared plumb and square by the installer and shall be of sufficient size to provide clearance at jambs, head and sill so as to allow for proper operation and maintenance of the doors. Installation of glass and glazing shall be performed by experienced technicians according to the manufacturer's recommended procedures. Units shall be securely anchored with joints fully caulked to ensure a water tight seal.

G. Cleaning: Upon completion of construction, the installing contractor shall be responsible for cleaning aluminum, employing methods recommended by the manufacturer as follows: Anodized aluminum shall be cleaned with plain water containing a mild detergent, or a petroleum product such as white gasoline, kerosene or distillate. No abrasive agent shall be used.

H. Performance Requirements: Air infiltration shall be tested in accordance with ASTM E283 and shall not exceed 0.06 CFM per square foot (0.003 m³/s·m²) of fixed area. Water infiltrations shall be tested in accordance with ASTM E331 with no water penetration at a test pressure of 6.24 P.S.F. (300 Pa). Structural performance shall be based on maximum deflection of 1/175 of the span, allowable stress with safety factor of 1.65. The system shall perform to these criteria under a windload for the Phoenix area.

08 14 00 WOOD DOORS

Description

This section applies to interior applications. Endangered or limited tree species are not allowable for wood door veneers. Doors receiving painted finishes, should be limited to low cost species (birch, maple, etc.). Welded hollow metal frames should be utilized. Knock-down frames are not allowed. Double door systems shall have a removable center mullion.

Wood doors with hollow metal frames are preferred for interior applications at the ASU at the Polytechnic campus.

Design Standard

A. All doors shall be solid core flush with veneer faces, commercial heavy duty minimum grade, 1-3/4 inch thick. Minimum width to be 3'-0". Maximum height to be 7'-0".

B. All doors should be specified from a single manufacturer.

C. Doors shall carry a life of installation warranty from the manufacturer.

D. Where doors are to be used as part of an acoustical barrier assembly, they shall be rated a minimum of STC 33.
E. Doors receiving a stained finish shall be specified as having premium quality face veneers, minimum thickness 1/16 inch.

F. Doors used as a normal means of ingress and egress shall have either vision panels or adjacent sidelights (where allowable by code) in metal frames.

H. Doors and frames shall have a spray applied finish where specified as described in 09 91 00.

I. Frames shall have wall anchors a minimum of 16 inch o.c.per jamb.

08 44 00 CURTAIN WALLS

Description

This section applies to exterior glazed curtain wall systems and storefronts (also used as fixed window systems). Curtain wall systems should be avoided on east and west exposures. South exposures will dictate the need for auxiliary shading devices, contributing to the composite system cost, and therefore should be seriously considered when analyzing both the aesthetic and cost appropriateness of the design.

Design Standard

A. The DP shall specify that a fabricator/erector shall have a minimum of 5 years experience of similar size and scope in the fabrication and erection of systems specified in the project.

B. Curtain wall systems shall utilize 1 inch, dual pane insulated glass, fully tempered.

C. Steel or a hollow metal type systems shall be specified. Aluminum alloy extrusions are not acceptable in areas that support or are directly adjacent to door openings.

D. "Kynar 500" or equal shall be specified for painted finishes, factory applied baked enamel.

E. Water penetration shall not occur at a test pressure of 7.00 psf when tested in accordance to ASTM E 331.

F. Maximum air infiltration shall not exceed 0.05 cfm per gross square foot of exterior area, when tested in accordance with ASTM E 283, section 4.3.

G. Where doors are utilized in curtain wall assemblies, at least one section of an exterior door assembly (main ingress and egress) shall have an electric automatic door opener, button activated at the swing side, interior and exterior.

H. In areas where the interior clear height of curtain walls exceed 30' (possibly an atrium) a system(s) must be designed to facilitate window washing without the use of erected scaffolding or movable lifts. See 11 24 23
I. On buildings that exceed 3 stories or 40' from finish grade, an exterior window washing system shall be designed. See 11 24 23

08 70 00 FINISH HARDWARE / ELECTRONIC CARD SYSTEM

Description

Hardware design and selection shall be reviewed and approved by the ASU Lock Shop.

This section applies to interior and exterior applications. Hardware is frequently a targeted item in budget "value engineering" efforts, causing a significant downgrading in quality which has proven to be directly attributable to total assembly failure in some university buildings. The use of cheaper or hard to get hardware not only compromises quality, but significantly increases maintenance. The DP should design and specify heavy duty commercial hardware for total life cycle value, and not compromise the initial selection based upon the "bottom line." The majority of hardware and parts inventory on ASU at Tempe campus is Schlage. Locks at the ASU at Polytechnic campus are manufactured by Best. Seek guidance from the appropriate individuals at ASU at the West campus for specific hardware requirement.

Design Standard

A. Hardware suppliers shall be specified as having a minimum of 5 years experience in supplying hardware for projects of similar size and scope, and shall have in his employ a certified architectural hardware consultant.

B. Lock Shop and end user shall review and decide on lock functions.

C. Door closures shall carry a minimum 10 year warranty from the manufacturer against failure or leakage.

D. Latchsets, locksets, hinges, panic devices, cylinders and holders shall carry a written minimum 5 year warranty from the manufacturer against failure. Hardware containing plastic parts are not acceptable.

E. All latches shall be roller type; all doors rim latching; all double doors with removable center mullion.

F. Mortise locks are not acceptable.

G. All hardware shall be commercial grade and have a finish that is easy maintainable and hides finger prints, 626 (26D).

H. All doors (interior and exterior) shall have lever action lock and latchsets (closed end), approved for use by the physically disabled.

I. ASU at the Tempe campus supplies the final key cylinder, Medeco Biaxial cylinders.. All hardware with key cylinders shall be compatible with Medeco cylinders. To be funded by the project.
J. Doors shall have a minimum of 3 heavy duty type institutional hinges per door.  
   Ex: Stanley FBB179/260

K. All exterior doors shall have thresholds, closures, weatherstripping, and mechanical hold opens and padded stops.

L. At least one section of an exterior door assembly (main ingress and egress) shall have an electric automatic door opener, button activated at the swing side, interior and exterior.

M. Kickplates are required of all doors that are subject to high traffic.

N. Restroom Entrance Doors:
   1. Doors shall open outwards.
   2. Doors shall have a deadbolt lock for securing "out-of-order" restrooms.
   3. Provide push panel on inside, pull handle on outside.
   4. No latching bolt mechanisms shall be provided unless required by Code.

O. The following manufacturer's and hardware type are acceptable at ASU at the Tempe Campus and is an example of the level of quality typical required by the owner: Contact Capital Programs Management Group to verify specific requirements at the various campuses
   1. General: Schlage Heavy Duty or equal (no plastic parts allowed);
   2. Door locks: cylinder type locks, Schlage Heavy Duty. Lever locks, Schlage Rhodes or equal;
   3. Dead bolts: heavy duty auxiliary type, Medeco D 11, Schlage B 400;
   4. All lever action hardware shall be Schlage "Rhodes" with cylindrical lock housing.
   5. Padlocks: Schlage 45101, Master 21, Medeco 50W080010;
   7. Surface mounted closures: LCN, Norton 7500 Series;
   8. Manual flush bolts: Glynn Johnson;
10. No plastic parts allowed inside or out.

11. Electrically controlled push pads shall be provided at all main building entrances and exits. Both hand and foot controlled pads shall be provided. Required pads and installation shall meet ANSI and ADA requirements and criteria.

P. Prior to substantial completion, the manufacturer rep, hardware supplier and installer jointly inspect and certify that all hardware on the project is properly installed and properly operating.

Q. Door closers shall be readjusted after the air balance is completed.

R. Unused parts on all locks, along with installation instructions, shall be turned over to the ASU Lock Dept.

S. Electronic Locks: Two types are used by ASU at Tempe campus as applicable to usage.

1. High Traffic, Proximity Type: Issac System by Henry Brothers (monitored).

2. Low Traffic, Card Swipe Type: Locknetics.

T. Laboratory Electronic Locks: These are a special application that will be designed in conjunction with Capital Programs Management Group and appropriate authority.

U. Coat hooks on wall behind office doors are to be provided at ASU at the Polytechnic campus. Color to be white.

08 80 00 GLASS AND GLAZING

Description

This section applies primarily to exterior glazing systems and windows. Generally, the DRB has highly discouraged the use of high reflectivity coatings on glazing products as being not acceptable to the character predominantly found on Campus. This will be held true for this section.

Design Standard

A. Dual pane, 1 inch insulated glass on all exterior windows. Sample pane(s) of color and reflectivity to be presented to the DRB at the schematic design review. Color glass which may not be available for future replacement over the lifespan of the building is discouraged.

B. All glass to be in contact with normal pedestrian traffic to be tempered float glass to a height of 8’ above floor surface adjacent to pedestrian traffic (or per code, whichever is stricter).
C. Wire glass is aesthetically allowable where dictated by code. The DP should try to capitalize on the intricate geometric patterning in the design.

D. Safety glass is recommended for use in railing areas, if so designed (in lieu of metal railings).

E. Sidelights and/or door lights to be minimum ¼" tempered float glass.

F. Individual windows or window assemblies shall be designed to easily accommodate washing of the exterior surface.

G. Exterior ledges of window openings (and other ledges) shall be designed to allow proper drainage away from the window assembly, 1/2 inch per foot is the minimum slope, 60° slope is preferred (to prevent bird nesting) although other designs (e.g. rounded ledges, etc.) will be considered by Capital Programs Management Group.

H. Ventilated windows are not to be operated with crank mechanisms unless windows are in tandem, in which case heavy duty industrial crank mechanisms shall be specified.

I. On buildings that exceed 3 stories or 40' from finish grade, an exterior window washing system shall be designed. See Section 11 24 23

J. All window assemblies shall be fully weatherstripped and gasketed.

NOTE: All glass types shall be a local stock item (not special order) to eliminate replacement delays.
DIVISION 09 - FINISHES

09 22 16 NON-STRUCTURAL METAL FRAMING

Description

This section refers to light gauge metal framing and should use a “performance specification”. Do not specify proprietary manufacturer’s names or materials, and do not restrict vendors to a limited list.

Design Standard

A. Minimum framing shall be 25 ga. galvanized metal studs on 16” centers to a maximum height of 12’. Minimum 20 gauge galvanized metal framing on 16” centers to be provided where wall heights exceed 12’.

B. In areas where partitions are subject to severe impact loads, and in situations where fixtures and appurtenances are intended to be supported directly from partitions, require the installation of backing and/or blocking in the partitions. Describe the locations for all backing and blocking on the drawings. Considerations for blocking are as follows:

1. Provide 20 gauge metal backing where numerous light weight fixtures are intended to be supported directly from the walls.

2. Provide 3 ½ “ blocking at the bottom of heavy duty partitions where resilient floors are scheduled to be installed (to protect walls from floor cleaning equipment impacts.)

3. Provide 6” high minimum wood blocking or 20 gauge metal at points of attachment for small fixtures, toilet accessories and partitions, handrails, door stops, etc.

09 26 00 VENEER PLASTER

Description

This section applies to interior areas that are subject to main traffic circulation or are subject to continual impact or heavy use.

Design Standard

A. The design should incorporate veneer plaster over metal lath in any interior area exposed to medium to high traffic or adjacent to potential impacts (corridors, restrooms, lobbies, elevator lobbies, etc.).

B. Specify an elastomeric based veneer plaster, application to comply with ASTM C843.

C. Minimum 3 coat application, 1/8 inch base coat, 1/16 inch final coat, for a total thickness of 3/16 inch.
D. Expansion joints shall be provided in accordance with manufacturers' recommendations.

09 29 00  GYPSUM BOARD

Description

This section addresses the installation and finish of Gypsum Board.

Design Standard

A. All application of Gypsum Board shall adhere to “APPLICATION AND FINISHING OF GYPSUM PANEL PRODUCTS (GA-216-2004)” or “APPLICATION OF GYPSUM SHEATHING (GA-253-99)” publications of the Gypsum Association and all ASTM specification it refers to.

B. All Gypsum Board finish levels shall adhere to “RECOMMENDED LEVELS OF GYPSUM BOARD FINISH (GA-214-96)” publication of the Gypsum Association and all ASTM specifications it refers to.

C. These and other Gypsum Board related references can be downloaded or purchased at: http://gypsum.org/download.html.

Quality Assurance

A. Newly applied Gypsum Board shall be inspected prior to finish to assure proper application and fastening.

B. The desired level of finish according to “RECOMMENDED LEVELS OF GYPSUM BOARD FINISH (GA-214-96)” must be indicated on design and construction drawings and specification.

C. Walls that are to receive “Walltalker” finish and other special areas as determined by the DP shall receive Level 5 finish. Provide Level 4 elsewhere.

D. Debris shall be removed from within cavity wall construction prior to application of gypsum board.

09 30 00  TILE

Description

This section applies to interior and exterior areas using ceramic tile for floors, walls, counter tops, wraps and architectural design accents. ASU's general philosophy is to specify materials that are made in the United States, although in this section, it may preclude the use of a wide variety of products and manufacturers. That being the case, this philosophy can be amended to manufacturer's of tile products that are widely available, have proven track records and have relatively short lead times in the production and shipping of the product.
Design Standard

A. Ceramic tile products should be specified that can endure high impact, low water absorption rates, and have low dimensional and color variations per order.

B. Minimum floor tile dimensions shall be 8 inch x 8 inch, matt finish (abrasive finish if exterior or lobby applied), and comply with the following requirements:
   1. Through color, 3/8 inch minimum thickness;
   2. Cove tile bases shall be used in all restroom applications;
   3. Tile inserts or accents in a predominantly matt or abrasive finish field may be polished or glazed;
   4. Grout joints should not exceed 1/8 inch. On flooring, a non white grout shall be designed and specified.

C. Minimum wall tile dimensions shall be 4 inch x 4 inch x 5/16 inch (unless a mosaic design is anticipated, in which case the minimum dimensions will be 2 inch x 2 inch), and comply with the following requirements:
   1. Restrooms to be glazed, flat tile, mud-set on wet wall(s), thin-set other. Tile shall be full height on the wet wall(s). All restrooms shall have at least the wet wall tile covered with wainscot on remainder;
   2. Grout joints should not exceed 1/16 inch;
   3. Interior or exterior walls other than restrooms (glazed only) may be glazed or matt finished.

D. A color of tile and grout should be chosen that is easily maintainable.

E. Epoxy mortars and grouts shall be used in all exterior applications, wet locations, areas subject to heavy traffic and areas that may come into contact with solvents, chemicals or continuous immersion in water.

F. Tile color and patterning should be clearly indicated by a sample and a colored sketch or plan and elevation at the final schematic design presentation.

G. Tile used on step treads shall have an abrasive finish or receive a rough finish imbed a minimum of 2 inch wide at the stair nosing, running the length of the tread.

H. Floor and wall surfaces to receive tile finishes shall be cleaned (vacuum and damp mop, minimum) prior to installation of tile.

I. An additional 2% tile shall be provided for maintenance stock.
09 51 00  ACOUSTICAL CEILINGS

Description

This section applies mainly to suspended acoustical tile ceiling applications. The ceiling plane has perhaps the first and largest aesthetic impact of an interior space, and careful design consideration should be given in the location of all lighting fixtures, diffusers or any other ceiling projection. Generally, office areas should be designed to accommodate a 9'-0" ceiling height.

Design Standard

A. 24 inch x 24 inch or 24 inch x 48 inch mineral fiber or noncombustible fiberglass panels, not less than 5/8 inch thick, with kerfed type edges.

B. Minimum NRC factor of 0.90 to 1.00, minimum STC rating of 25 to 29, minimum reflectance 75%.

C. Concealed spline systems are not acceptable.

D. Specification should call for 2% additional material over actual material installed.

E. Suspension grid to be exposed, heavy duty T type.

F. Lighting, diffusers and sprinklers should be designed to occur in the system at regular or predetermined intervals. Do not count on subtrades locating ceiling penetrations in locations that are logical or in the center of a panel.

G. Where walls run to the underside of the system, design and specify an acoustical seal where they meet.

H. Surface texture(s) should be chosen that offer low maintenance and can be periodically cleaned.

J. Maintain a 6" minimum clearance between the top of the grid and all other systems installed above the ceiling.

K. If exception is taken to any item above, the DP shall clearly demonstrate to ASU a better or "or equal" alternative for approval.

09 63 40  STONE FLOORING

Description

Generally, the project budget will preclude the use of large areas of stone flooring, however in limited areas and as accents, the material can greatly enhance the overall aesthetic character of the design.

Design Standard

A. 48 inch x 48 inch maximum single panel size. Thick-set on a concrete substrate.
B. 3/4 inch minimum thickness. The use of polished or honed stone as the predominant field material is not acceptable, except as a border or accent treatment.

C. The use of soft varieties of stone and stone with soft veining or stones that are naturally porous and permeable, are not acceptable. Naturally clefted stone such as slate should also be avoided due to maintenance difficulty and the high degree of possibility of improper maintenance.

D. Stone used on step treads shall be crossed grooved or receive a rough finish or imbed, a minimum of 2 inch wide at the stair nosing, running the length of the tread.

E. Additional panels shall be provided for maintenance stock.
   1) Provide two 48 inch by 48 inch spare panels, or;
   2) Provide 4 tiles on other panels smaller than 48 inch.

09 65 00 RESILIENT FLOORING

Description

This section includes vinyl composition tile (VCT), rubberized flooring tile and rubber bases. Generally, the project budget will lend itself to large areas of this type of flooring, however durability, maintenance and acoustics should be carefully weighed against the initial cost of installation. Although this is the predominant flooring material used at ASU, its aesthetic appeal usually begins to wane in 5 to 7 years.

Design Standard

A. 12 inch x 12 inch x 1/8 inch single tile size, composition 1, asbestos free, heavy duty commercial. Linoleum sheet goods are not acceptable.

B. VCT critical radiant flux not less than 0.45 watts per sq. cm.; flame spread not more than 75 per ASTM E 84; smoke developed not more than 450 per ASTM E 84; smoke density not more than 450 per ASTM E 662.

C. A color should be specified that is easily maintainable.

D. 4 inch x 1/8 inch coved rubber bases, dark in color to hide impact marks, matte finish. ASU at the Polytechnic requires the use of rubber coved base throughout with color to match door/window trim.

E. Exposed edges of resilient flooring to have butt type extruded aluminum edge strips.

F. Specification should call for 1 box per 50 or any fraction thereof additional material for each color, pattern or type used.
09 66 00   TERRAZZO

Description

ASU has had very successful experiences in using terrazzo on floors in high traffic areas and on walls in restrooms. Terrazzo is an extremely durable product and is recommended for design consideration in corridors, lobbies, and restrooms in heavily used facilities, budget permitting.

Design Standard

A. The DP should specify that installers be limited to companies specializing in full bed terrazzo applications with documented experience and a member of the National terrazzo and Mosaic Association and have a minimum of 5 years relative experience in size and scope similar to the project.

B. Total terrazzo minimum thickness not less than 3/4 inch.

C. Reinforcing mesh, minimum 2 inch x 2 inch x 16 gauge, galvanized should be specified.

D. Aluminum oxide non-slip aggregate to match surface aggregate should be specified.

E. Control and divider strips shall be 1/4 inch width, zinc topped, recommended maximum placement not exceeding 8'-0" x 8'-0".

F. An aggregate and matrix color should be chosen that is easily maintainable.

G. Cove terrazzo bases shall be used where terrazzo is used as a flooring material.

H. 1/4 inch sand cushion is recommended over the structural floor substrate.

I. Terrazzo used on step treads shall be crossed grooved or have a rough finish imbed a minimum of 2 inch wide at the stair nosing, running the length of the tread.

09 68 00   CARPET

Description

A heavy duty commercial grade will wear well for over 10 years and is worth a higher initial cost, particularly due to the fact that most User operations budget do not have sufficient funds for carpet replacement. Carpet should be avoided in high traffic areas (main lobbies, main corridors) or area(s) prone to chemical, food, printing or reproductive media (copy rooms) or water.

Verify current ASU Carpet Policy and Standards to ensure compliance. Use of carpet tile, grade of carpet and other requirements shall be in compliance with ASU Carpet Policy and Standards.
ASU at the Polytechnic campus requires the use of carpet squares; no rolled goods are to be specified unless conditions require its use.

**Design Standard**

A. Seek guidance from the appropriate ASU group regarding specific carpet products to be used for a specific project.

B. Specify extruded or molded rubber carpet edge guards at flooring material transitions.

C. A color and pattern should be specified that is easily maintainable.

D. All carpet seams shall be hot melt seaming material.

E. Specify that a seaming diagram be submitted prior to carpet purchase, for review by ASU.

F. Specification should call for 1% additional material over actual area used.

G. Specify that all firms that will bid this section have a minimum of not less than 2 years of carpeting experience, similar to the size and scope contained in the project.

H. Specify a special project warranty from the installer of a minimum of a 2 year full warranty to fix, repair or replace carpeting failure as the result of defective workmanship.

I. 4 inch x 1/8 inch coved rubber bases, dark in color to hide impact marks, matte finish.

J. Ten (10) year written warranty.

K. Specify that carpet shall not be installed until other work (drywall installation, painting, etc.) is completed.

**09 68 13 CARPET TILES**

**Description**

Carpet tile can be considered in areas that favor its use, such as areas that will be used for dining where continual food spills will necessitate continual replacement.

Verify current ASU Carpet Policy and Standards to ensure compliance. Use of carpet tile, grade of carpet and other requirements shall be in compliance with ASU Carpet Policy and Standards.

ASU at the Polytechnic campus requires the use of carpet squares; no rolled goods are to be specified unless conditions require its use.
Design Standard

A. Seek guidance from the appropriate ASU group regarding specific carpet products to be used for a specific project.

B. A color and pattern should be specified that is easily maintainable.

C. If the design indicates a uniform color with no individual pattern, individual tiles should be installed in alternating nap directions to create a pattern (seams are presumed always visible no matter what the claims of the installer and/or manufacturer are).

D. Specification should call for 1% additional material over actual area used.

E. Specify a manufacturer with not less than 5 years production experience with the carpet tile type specified, and who can comply with a 10 year warranty against wear, static, edge-ravel, delamination, shrinkage, curling and doming.

F. Specify that all firms that will bid this section have a minimum of not less than 2 years of carpeting experience, similar to the size and scope contained in the project.

G. Specify a special project warranty from the installer of a minimum of a 2 year full warranty to fix, repair or replace carpeting failure as the result of defective workmanship.

H. 4 inch x 1/8 inch coved rubber bases, dark in color to hide impact marks, matte finish.

09 69 00 ACCESS FLOORING

Description

This section applies to areas that will house a very large number of personal type computers that will be occasionally rearranged, added to, or networked differently depending on the change in use. Typically, the floor type elaborated on below are raised "pedestal" systems, +/- 6 inch.

Design Standard

A. Floor panels specified to comply with a uniformed live load of 250 lbs per sq. ft.; concentrated load of 1000 lbs. anywhere on a 1 inch square; deflection not to exceed 0.080 inch, permanent set not to exceed 0.10 inch.

B. Pedestals capable of resisting a 5000 lb. axial load per pedestal and resistance to horizontal force of 20 lbs. applied to the top of the pedestal in any direction.

C. Not more than 10 ohms resistance between panel and under structure.

D. Panels shall be 24 inch x 24 inch, steel covered wood core panels, fabricated with 1 inch thick high density particle board, top and bottom faces to be zinc.
coated steel.

E. Pedestals shall be heavy duty, column assembly, stringerless type with vibration proof mechanisms.

F. Areas receiving a raised or pedestal floor system shall have area floor drains at the structural floor slab.

09 72 00 WALL COVERINGS

Description

Application of Wall Coverings are discouraged because of difficulties in maintainibility and repair when damaged.

Design Standard

A. The DP shall submit a sample of color and texture of the proposed product at the final schematic design submittal.

B. Specify a special project warranty from the installer of a minimum of a 2 year full warranty to fix, repair or replace covering failure as the result of defective workmanship.

C. Specify that installers have a minimum of not less than 3 years of wall covering experience, similar to the size and scope contained in the project.

D. Two full rols of same size material used shall be provided for maintenance stock.

09 91 00 PAINT

Description

This section applies to exterior and interior areas or surfaces that are to receive a painted final finish. Surface preparation, priming and coats of paint are in addition to shop-applied primers. Large areas of painted exterior surfaces exposed to view should be avoided due to the annual or biannual cost of maintenance. Painted exterior features exposed to view that are generally inaccessible without special scaffolding or working platforms should also be avoided.

Design Standard

A. A paint schedule listing colors, locations and types shall be included in the construction bid set, either as part of the finish schedule or as part of the paint specification.

1. Changes from the approved paint due to unavailability or other reasons will require approval prior to application by the DPM.

2. ASU at the Polytechnic campus uses specific paint colors as follows
a. Walls:

1) Interior walls of all rooms – offices, classrooms, labs, etc.
   a) Dunn-Edwards – Linen or Swiss Coffee
   b) Frazee – Hayseed
   c) Pre-approved color from another manufacturer

2) Hallway, reception, restroom walls – pre-approved accent colors allowed.

3) Flat finish preferred.

b. If a deviation from the standard colors is allowed, then a minimum of one gallon unused and unopened container, for each color, shall be provided for future maintenance.

B. Areas of Work

1. Do not indicate painting when factory finishing or installer finishing is specified for such items, such as metal toilet partitions, pre-finished partition systems, acoustic materials, architectural wood and casework, elevator entry doors, frames, and finished MP&E equipment.

2. Do not indicate painting in areas that will be concealed or are generally inaccessible.

3. Do not indicate painting of finished materials such as anodized aluminum, stainless steel, chromium plate, copper, bronze, or other similar finished materials or surfaces.

4. Do not indicate painting of moving parts of operating units, MP&E parts, linkages, etc.

5. Surfaces that are to receive spray-on fireproofing are not to be painted or primed.

6. Care should be exercised and referenced in the specifications to protect and/or mask code-required labeling, equipment identification plates, performance rating labels, and nomenclature plates.

C. Quality Assurance

1. Primers and other undercoat paint shall be supplied by the same manufacturer of the finish coats.

2. All paint materials (whether primers, thinners or finish) must be a manufacturer's standard, best grade product(s), with the manufacturer's product literature identifying the material or product as such.

3. Primers, back-primers, undercoats and finish coats must be designed and
specified as a total assembly, adhering to all manufacturer's directions and recommendations. Material types must be chosen considering the surface nature to be covered, location of the surface, and the environmental conditions the surface and materials will be in continual and occasional contact with.

4. The use of “recycled” paint is encouraged, but is not mandated.

D. Preparation

1. Specify the removal of hardware, hardware accessories, machined surfaces, plates, fixtures and like items in the area adjacent to the surface to be painted or specify that a surface applied protection be provided for such items prior to the start of the work.

2. Concrete, concrete block, cement plaster must have all efflorescence, chalk, dust, dirt grease, oils, etc. removed by roughening prior to the application of primer or finish paint coats.

3. Concrete floors to be painted must be cleaned with a commercial solution of muriatic acid or other etching cleaner.

4. Wood surfaces must be cleaned prior to priming, painting or staining with mineral spirits or light grit sandpaper (thoroughly dusted afterwards).

5. Gypsum wall board shall be cleaned prior to priming and painting by light grit sanding and/or dusting with a moderately damp cloth or sponge.

E. Application

1. All surfaces to receive finish painting shall be primed if not primed by the manufacturer or shop, in accordance with the paint manufacturer's recommendations.

2. All surfaces shall receive as a minimum two coats of finish paint, allowed to dry completely between coats, applied to the manufacturer's recommendation per coat thickness and application rate.

3. Recommended application techniques:
   a. Metal: Spray applied.
   b. Walls: Spray or rolled applied.
   c. Floors: Spray or rolled applied.
   d. Doors and jambs: Spray or Brush applied.
   e. Millwork/Casework (prominent): Spray applied.
F. Finishes

1. The use of flat paint finishes (whether field applied or factory) are not acceptable in areas or on surfaces that will be subject to human contact, direct sun exposure, exposure to water, solvents or cleaning materials, or frequent abrasions.

2. High gloss finishes are not acceptable in areas where reflective glare may be a concern (areas that contain computer terminals) or on surfaces that are in continual human contact.

3. Acceptable finishes for most areas, surfaces or features are velvet flat, eggshell, satin, and semi-gloss.

G. Exterior exposed metal fabrications shall have a spray applied epoxy-polymide type primer (as described in 05 50 00), finish paint coat(s) shall also be spray applied- Kynar or equal. A color should be chosen that does not easily fade when exposed to sunlight.

H. Interior exposed metal fabrications shall have spray applied epoxy-polymide type primer paint (as described in 05 50 00) and spray applied finish paint- epoxy based and/or electrostatically applied. A color should be chosen that does not easily fade when exposed to sunlight and hides hand prints.

I. Where metal stair risers are exposed (not covered), they shall have have spray applied epoxy-polymide type primer paint (as described in 05 50 00) and spray applied finish paint- epoxy based and/or electrostatically applied. A color should be chosen that does not easily fade when exposed to sunlight and hides shoe scuff marks.

J. At the top and bottom of stair landings, a contrasting color and texture to the normal stair treads shall be used to facilitate the blind and visually impaired.

Quality Assurance

A. All painted surfaces shall have consistent color and sheen throughout any continuous, flat areas.

B. Any touch-ups or repainting required for punch lists needs to be indistinguishable. This most often would necessitate painting whole sections of a given surface where the finish can be squared off at a corner or other break in the surface.

C. All finished surfaces shall comply with PDCA Industry Standards of 2004. PDCA standard are available at: http://www.pdca.org/
09 96 23 GRAFFITI-RESISTANT COATINGS

Description

Application of graffiti-resistant coatings is discouraged because of potential difficulties in future maintenance, however, it is recognized that in some installations a clear anti-graffiti coating may be necessary to provide protection of certain exterior façade materials, such as stone.

Design Standard

A. Graffiti-resistant coating shall be permanent and shall not require re-application upon removal of graffiti.

B. Graffiti-resistant coating shall leave the finished surfaces uniform in appearance and not alter the natural color and texture of the material to which it is applied.

C. The DP shall submit a sample of the graffiti-resistant coating applied to the intended substrate material at the final schematic design submittal.

09 97 00 SPECIAL COATINGS

Description

This section defines special coatings as elastomeric paint on all exterior stucco or plaster work. Work under this section would consist of application of high build, acrylic maintenance coating designed to bridge cracks and remain watertight, flexible, and colorfast for longer than normal paint applications.

Design Standard

A. The DP shall submit a sample of color and texture of the proposed product at the final schematic design submittal.

B. All elastomeric coatings shall be specified as requiring a 5 year guarantee.

C. Elastomeric coatings shall be specified for any area of exterior stucco or PC plaster, whether new or existing.
DIVISION 10 - SPECIALTIES

10 11 00 VISUAL DISPLAY BOARDS

This standard for visual display boards does not include classrooms, teaching halls, or auditoriums where teaching will occur. For classrooms standards, see the Classroom Design Guidelines, provided by the Office of the University Architect (OUA).

Viewing Guidelines

1. In order for the most distant viewer to read characters and symbols, the viewer should not be more than 8 times the image height from the screen.

2. In rooms where increased visual impact is desired, the viewer should not be more than 6 times the image height from the screen.

3. The minimum distance to the first row of seats should be 2.5 times the image height from the screen.

4. The maximum viewing angle for viewing should be 40 degrees when measured from the opposite edge of the image.

Description

This section applies to dry markerboards, and natural cork tackboards. See Classroom Design Guidelines, provided by OUA, for information pertaining to visual display boards in teaching areas.

All vertical writing surfaces shall have a continuous tray at the base for markers and erasers. They shall also have a top 1 inch cork strip. Four sets of markers shall be included with every 8'-0" of marker board. Two erasers shall be included with every 8'-0" of marker board. Four map clips shall be included with every 8'-0" of marker board.

Design Standard

A. Specify a 50 year replacement warranty for porcelain boards covering boards that do not retain their original writing and erasing qualities, become slick and shiny, or exhibit crazing, cracking, or flaking.

B. Chalkboards shall be:

1. Vitreous porcelain boards, a face sheet of 24 gauge enameling grade steel, with a 3 coat porcelainize process, writing coat greater or equal to 0.0025 inch.

2. The core material shall be a minimum 3/8 inch thick industrial grade particle board, complying with ANSI A208.1, Grade 1-M-1.

3. Backing sheet shall be 0.015 inch aluminum. Laminating adhesive shall consist of moisture resistant thermoplastic adhesive.
4. Color of finished face shall be green or black, non glare, reflectance less than 20% and greater than 15%.

C. Fabricated frames and trim shall be clear anodized aluminum, not less than 0.062 inch. Marker trays shall be aluminum, solid extrusion with a ribbed section, with smoothly curved ends.

D. Dry markerboards shall be:

1. porcelain boards, a face sheet of 24 gauge enameling grade steel, with a 3 coat porcelainize process, writing coat greater or equal to 0.0025 inch.
2. The core material shall be a minimum 3/8 inch thick industrial grade particle board, complying with ANSI A208.1, Grade 1-M-1.
3. Backing sheet shall be 0.015 inch aluminum. Laminating adhesive shall consist of moisture resistant thermoplastic adhesive.
4. Color of finished face shall be white, non glare matte type finish.

E. Cork tackboards shall have a single layer, 1/4 inch thick, seamless, compressed fine-grain natural cork sheet, sanded for a natural finish, complying with MS MIL-C-15116, Type II.

F. The minimum vertical writing surface area per room should never be less than 64 sf and typically should be 80 sf.

10 14 00 SIGNAGE-AND WAYFINDING

Description

This section applies to all interior and exterior spaces of buildings and common spaces that require directional signage, room numbering and identification, information plaques, etc. This section does not include signage that can be termed code-required or "emergency" type signage (fire exits, emergency labeling or direction, etc.). The type of signage and graphic standards that will be applicable to all ASU projects are defined by ASU Environmental Graphic Design Group. Outlined below is the appropriate procedure for implementation of interior signage.

Design Standard

A. All interior and exterior signage will conform to the requirements as set forth by the ASU Office of the University Architect and the ASU Communication Guide.

B. The DP shall confer with the Office of the University Architect for individual project specifications.

C. The DP in conjunction with Capital Programs Management Group and the Office of the University Architect shall determine the appropriate room numbering of all interior space prior to final schematic design. No other room numbers shall
appear on the plans other than those approved by Office of the University Architect.

D. The DP and/or the CM shall carry an allowance amount as directed by Capital Programs Management Group (including directories and exterior building plaque), in their estimates, and identify this money as a separate construction line item, from the architectural program onward.

F. The DP in conjunction with the Users and the Office of the University Architect shall determine the applicable signage types, amounts and location no later than the construction document phase, for the purposes of bidding with general construction.

G. The DP in conjunction with Capital Programs Management Group and Office of the University Architect shall ensure that ADA requirements for signs and wheelchair maneuverability are met. Building floor planning (location and swing of doors, etc.) shall allow for wall space as may be required to comply with ADA requirements.

10 21 13 TOILET COMPARTMENTS

Description

This section applies to restroom partitions and screens, but also generally applies to the space itself. Restroom toilet partitions and screens are the single most abused elements on campus, partially due to design and detailing that is inappropriate for heavy institutional use. The DP should carefully consider design concepts that facilitate easy maintenance, safety, complete accessibility to the handicapped, and extreme durability.

Design Standard

A. All partitions and screens shall be galvanized steel sheets with 2 coats of thermo setting enamel finish applied by an electrostatic process and baked (Santana products or equal). Color should facilitate easy maintenance and be a gloss finish. Gauges to be as follows:

1. Overhead braced pilasters, 20 gauge;

2. Unbraced pilasters, 16 gauge;

3. Panels and screens, 20 gauge;

4. Doors, 20 gauge;

5. Concealed anchorage reinforcement, minimum 12 gauge;

6. Concealed tapping reinforcement, minimum 14 gauge;

7. Core material sound deadening honey comb; minimum 1 inch thick for doors, panels and screens; 1 1/4 inch minimum for pilasters;
8. Pilaster shoes (at ceiling) stainless steel, not less than 3 inch high, 20 gauge;

9. Hardware and accessories commercial heavy duty, chromium plated;

10. Anchors and fasteners, stainless steel or chromium plated steel (to match hardware).

B. All partitions to be ceiling mounted, wall secured.

C. All accessories shall be chromium plated finished.

D. Handicapped compartment shall be 5'-0" wide, with a 32 inch minimum clear door opening width, door to swing outward.

E. Ordinary toilet stalls shall have 24 inch clear door opening width(s).

F. Individual screening of urinals in gang arrangement is not acceptable. A single screen adjacent to a lav arrangement is acceptable.

G. Restroom design should incorporate a low built-in shelf (48 inch) to place books, handbags, etc.

H. Restroom design should hide direct lines of sight into the room without the use of a two door type vestibule, one door to the room is preferable.

I. Minimum one floor drain per restroom.

J. See section 10 28 13 for toilet accessories.

10 22 26 OPERABLE PARTITIONS

Description

This section applies to operable partitions used to functional and acoustically dimmise large areas of general use space. The type of partitions that apply specifically are those that consist of floor to ceiling stackable panels on a track system, but may apply acoustically to accordion type partitions.

Design Standard

A. Minimum STC composite rating of 50, tested on 100 sf. opening.

B. Minimum in field performance equal or better than ASTM E336.

C. Installed track deflection under full load no greater than 1/360.

D. Minimum panel thickness shall be 4 inch, panel skins rated Class A, in full perimeter protective steel frame.

E. Vertical sound seals between panels will be tongue and groove, consisting of steel astragals incorporating vinyl acoustical seals.
F. Horizontal top seals shall be twin-finger continuous contact type. Mechanical bottom seals shall be made of formed steel, incorporating 1/4 inch vinyl strips for proper acoustical seal when activated.

G. Hinges on panels and inset pass doors are recessed and project no more than 1/4 inch beyond panel face.

H. Footbolts and stabilizers shall be internal and edge activated. No protruding footbolts attached to panel faces are allowed.

I. Suspension system shall consist of a steel track connected to structural support by threaded rods. Each panel of a paired assembly shall be supported by one carrier assembly consisting of steel ball bearing wheels. Each panel of an individual panel assembly shall be supported by two carrier assemblies consisting of steel ball bearing wheels.

J. Plenum closure is required for maximum sound control of the partition and must permit lifting out of header panels to adjust track height.

10 26 13 CORNER GUARDS

Description

This section applies generally to the need and location of corner guards. Guards should be considered in all areas subject to heavy traffic and potential impacts (e.g. areas that have catering/food service function), and designed in such a manner that does not give the aesthetic appearance of a "tack on" or a design oversite.

Design Standard

A. Surface mounted, clear polyester or metal; minimum 2-1/2 inch x 2-1/2 inch x 48 inch.

B. Apply to exposed-to-view 90 outside corners of walls and columns.

C. Finish may be compatible with adjacent finishes, but must be durable and highly resistant to scratches, nicks, gouges, etc.

10 28 13 TOILET ACCESSORIES

Description

This section includes toilet accessories that are typical to the majority of projects on Campus, and does not include special or unusual items that may be applicable on specific projects. In general, manufacturers, models and types are listed both as a quality and functional standard. The DP, in design and specifying of toilet accessories, may elect to use other manufacturers, however the features and quality will have to the same as those listed.
Design Standard

A. All accessories shall be stainless steel with polished No. 4 finish or nickel chromium electro-deposited on base metal, conforming to ASTM B 456, Type SC 2, satin finish.

B. Soap dispensers: surface mounted, sani-fresh twin pack, 500 ml system. One per lavatory, located directly above the lav, not to the side.

C. Toilet tissue dispensers: Scott JRT Jr. Escort panel surface mounted opposite door swing, twin roll, one per toilet compartment.

D. Paper towel dispenser: recessed combination dispenser and waste receptacle; roll towel type with 5 inch cut-off on towels; wall-mounted, Scott Capacitor, twin roll.

E. Sanitary napkin dispensers: wall mounted, Rochester Midland, J6 with a minimum 25-cent coin mechanism. Equipped with a coin box lock and door lock with locking bar.

F. Sanitary napkin disposal unit: panel surface mounted; stainless steel with bottom dump. One per toilet compartment.

G. Coat hooks: one per toilet compartment with rubber end shock absorber.

H. Mirrors:
   1. One mirror per lav, wall mounted, 18 inch x 24 inch; one full length mirror per restroom;
   2. Each conforming to FS DD-G-451, Type I, Class 1, Quality q2, 1/4 inch thick, with silver coating, copper protective coating, and nonmetallic paint coating.
   3. All mirrors must have a moisture sealant applied to all edges.

I. Grab bars: at handicapped compartments; 1-1/2 inch diameter, knurled stainless steel finish.

10 44 00  FIRE EXTINGUISHERS

Design Standard

A. All labs or any other area that may be considered high hazard requires a fire extinguisher cabinet (s) with an extinguisher(s) meeting the minimum rating of 2-A:20-B:C. The extinguishing agent must be ammonium phosphate. Areas with flammable metal hazards require a class "D" fire extinguisher. Travel distance to a fire extinguisher in these areas are not to exceed 50 feet. Carbon dioxide or halon agents are not acceptable.
B. Mechanical rooms, electrical rooms and commercial kitchens will need a fire extinguisher cabinet(s) with an extinguisher(s) meeting the minimum rating of 20-B:C rating. The extinguishing agent must be of sodium bicarbonate base or of a potassium bicarbonate base. Carbon dioxide or halon agents are not acceptable. Travel distance to a fire extinguisher cannot exceed 50 feet. Fire extinguishers outside the room/area of protection cannot be included in the travel distance requirements.

C. Corridors and all other areas requiring fire extinguishers that are not categorized in areas mentioned above or are considered light hazard to ordinary hazard areas will require a fire extinguisher cabinet and an extinguisher with a minimum rating of 4-A:20-B:C. Extinguishing agent must be ammonium phosphate. Travel distance to a fire extinguisher must not exceed 75 feet.

D. All fire extinguishers must be UL approved and bear an individual identification on the fire extinguisher.

E. The cylinder head and internal parts must be constructed of steel or aluminum. Stainless steel cylinders or any other cylinders requiring normal hydrostatic testing less than every twelve years are not acceptable.

F. The manufacturer of the fire extinguisher must be one of the following: Amerex, Ansul, Buckeye, General, Kidde, or any manufacturer that can meet all requirements in this section and can be serviced with the equipment, adapters, and parts that ASU Environmental Health and Safety currently use and maintain (inventory and service).

G. All fire extinguisher cabinets, if provided with locks, must be key operated by the standard Larsen LL24 key.

10 81 00 PEST CONTROL

Description

This section applies primarily to the exterior areas of the building relating primarily to controlling damage and limiting maintenance costs due to birds and other animals, as well as humans.

Design Standard

A. The use of mechanical, electrical, physical, and chemical repellant systems, and protective devices specifically designed for bird and animal control shall not be allowed unless approved by the Capital Programs Management Group. The building design should address the elimination of possible roosting and rookery locations on window sills and shading devices by means of sloping top surfaces or other means acceptable to ASU.

B. Openings in building facades for pipe penetrations and due to changes in materials shall be carefully detailed and constructed to eliminate possible entrance points into the building for bats, birds, insects, rodents and other animal
pests.

C. Skateboards: Although skateboarders are not specifically "pests" that require control, potential damage and continuing maintenance to horizontal building elements due to skateboards should be taken into consideration in the building design. Freestanding railings and narrow copings at ground level are attractive to skateboard users and the sliding of the skateboards over these building elements requires constant maintenance, therefore these types of elements should be eliminated where possible.
DIVISION 11 - EQUIPMENT

11 14 43 THEFT DETECTION SYSTEMS

Description

This section applies to theft detection and security systems in any area of the building that utilizes materials that have a sensitive nature to them or in areas that have movable equipment and/or resource materials. In recent years, theft on campus has put a tremendous drain on financial resources of departments and is approaching epidemic proportions. All buildings should incorporate some type of theft detection system(s), and at the least some type of reporting system/ card access at all entries from the exterior, particularly in Residence Halls.

Design Standard

A. In the architectural programming phase, the DP should assess, with the participation of ASU DPS, ASU Electric Shop, and the Users, needs regarding security and the possible extent and type of that security. The program budget should reflect these discussions as a line item for future elaboration.

B. No matter what type of system is developed, it will be required to directly report back to the DPS central computer station.

C. All interfaces will have to be compatible with the control DPS system (e.g. Johnson Controls, ASU at Tempe campus, and Simplex, ASU at West campus). Contract Capital Programs Management Group for information regarding the existing control DPS system for each project at the various campuses.

D. The DP shall review all technical requirements of the proposed system with ASU DPS and ASU Electric Shop prior to design development.

E. Current preferred system includes MOOSE or approved equal by ASU Electric Shop.

11 24 23 WINDOW WASHING EQUIPMENT

Description

This section applies to exterior window washing support systems that will be required when a building is over 3 stories or 40' in height from average natural grade.

Design Standard

A. The DP shall in the schematic design phase, work closely with a company or firm that specializes in the manufacturing and supply of the system. The system shall be an integral element in the design and not left as an oversite.

B. Acceptable manufacturers of the equipment shall be Equicon, Spider Staging Sales Co., Swing Stage Inc., and Titan Staging and Engineering, Inc.
C. A davit type system shall be utilized in the design of the building exterior. The system shall be designed with a total safety factor of 4 to 1 against overturning moment.

D. All supports shall be welded construction. Supports shall be hot dipped galvanized after fabrication. Support sleeves shall be minimum schedule 40 steel pipe, conforming to ASTM A 53.

E. Davit sockets shall be either mobile hinged or fixed type, designed with a total safety factor of 4 to 1 against overturning moment. Socket sleeves shall be minimum schedule 40 steel pipe, conforming to ASTM A 53. Sockets shall be hot dipped galvanized after fabrication.

F. Cable tie backs shall be vinyl covered stainless steel cables, attached to the building with spring loaded, quick release fasteners and cables with spring loaded clips. All cable tie back receptacles shall be firmly anchored in the wall construction, per manufacturers recommendation.

G. ASU does not supply the actual movable platform, and should not be specified as doing so.

H. A 6' minimum walkway shall be provided in all roof areas the system will need to operate to gain access to the building facade. This walkway may consist of a built-up cementous surface, raised industrial type walkway, or built-up pad, but it cannot compromise normal roof drainage or undermine the integrity of the roof in anyway.

11 52 13 PROJECTION SCREENS

IT Connections Required for Projection Screens

1. The campus should provide satellite uplink/downlink capability to transmit live and taped program material to and from remote sites. Satellite transmission would be especially appropriate for educational outreach programs due to the increasing number of satellite receivers at homes and meeting sites.

2. Receive only dishes should be located at remote campus locations, businesses, etc. to receive programming sent from the ASU campus.

3. Each building with classrooms on campus should be connected by a campus-wide fiber optic distribution system. The system would allow distribution of live and taped programming from larger "sending" classrooms or from satellite feeds received through the satellite downlink.

4. A transmission system should be provided that will allow audio teleconferencing in selected learning spaces. This system could be used for interactive training sessions between remote sites and should interface directly with the satellite uplink for communications consisting of one-way video with two-way audio.
5. Large learning spaces should provide large screen, high quality video images with audio playback utilizing all formats of video sources.

6. The designated transmission source "sending" rooms should be equipped with appropriate cameras and microphones to allow recording of events for playback or simultaneous transmission to remote sites.

General Recommendations

1. All classrooms should have conduits linking them to (a) the campus-computer network, (b) the Educational Television and Radio Office's network (where appropriate), and (c) the campus telephone system.

2. Selected rooms should be equipped with a video display device capable of handling signals from regular television and as many of the campus-supported computers as possible.

Since video images can be quite dim and susceptible to serious degradation from ambient light, lighting designs require special attention in rooms where video display devices require special attention.

Electrically Operated Projection Screens

Description

This section applies to electrically operated projection screens. The standard does not include classrooms: for classrooms standards, see the Classroom Design Guidelines, provided by the Office of the University Architect (OUA). All other areas specified by ASU shall include screens that comply with the following requirements:

Design Standard

A. Front projection screens, electrically operated with remote control switches.

B. Each type of screen shall be specified as requiring complete units, including all mounting and accessory hardware, from a single manufacturer.

C. Matte white viewing surface with:
   1. Minimum grain characteristics complying with FS GG-S-00172D(1) for Type A screen surface;
   2. Mildew and flame resistant glass fiber with vinyl coated viewing surface;
   3. Designed and fabricated for recessed installation.

D. Edge treatment without black masking borders.

E. Three position single switch station control.

F. Size and location per applicable area as specified above in "Viewing Guidelines."
G. Projection screens should be mounted at the front center of the room and are mounted approximately 3 inch from the wall to allow clearance of the chalkboard tray.

H. The minimum project screen size is an 8'-0" x 8'-0" screen, ceiling recessed.

I. Sightlines should be analyzed for all seats within the room.

Viewing Guidelines

These viewing guidelines are not for classrooms. See Classroom Design Guidelines, provided by the Office of the University Architect or OUA, for information pertaining to projection screens in teaching areas.

1. In order for the most distant viewer to read projected characters and symbols, the viewer should not be more than 8 times the image height from the screen.

2. In rooms where increased visual impact is desired, the viewer should not be more than 6 times the image height from the screen.

3. The minimum distance to the first row of seats should be 2.5 times the image height from the screen.

4. The maximum viewing angle for viewing should be 40 degrees when measured from the opposite edge of the projected image.

5. The distance from video monitor screens should be restricted to 4 to 6 screen diameters for laboratory, medical and technical viewing where image clarity and resolution are important; 5 to 10 screen diameters for general instructional viewing; and 10 to 12 screen diameters for general viewing where detail resolution is not important.

11 53 13 LABORATORY EXHAUST AND FUME HOODS

Description

This section applies to exhaust and fume hoods in spaces designated for use as chemical laboratories. Laboratory fume exhaust systems must be designed as complete operating units considering chemical use factors, room supply air, room configuration, hood type and location, exhaust fan, and ductwork.

Laboratory design and specifications must be developed with guidance from the appropriate authority.

Design Standard

A. General
1. Hood exhaust ducts shall be sized for a transport velocity consistent with design noise levels, duct static pressure, size limitations and fan tip speed.

2. Fume exhaust ducts shall be constructed of PVC, fiberglass or stainless steel. Fittings shall be factory fabricated, jointed and sealed. Perchlorics require the use of other materials, so each installation should be studied and reviewed with P&C.

3. Hoods in air conditioned space are to have adequate outside make-up air. Fume hood fans shall be of industrial type, (American Blower, Buffalo, Clarage, or approved equal), properly protected against corrosive gases, weather-proofed, and belt driven.

4. Flexible connections shall be installed at all fan inlets. Material shall be a minimum of 28 ounce coated glass fabric as manufactured by Elgen (SDN-4), Vent Fabrics, Inc., Duradyne Co., or approved equal. Material must be fire retardant, waterproof and airtight.

5. Fume hood exhaust through roof should have vertical fan outlet ducts that terminate at least 7’ above roof.

6. Where fume hoods are not installed initially but planned, provisions must be made for their later installation, in the form of ducts roughed in to the building structure or access provided for their subsequent installation.

7. Any volume or balance dampers used in a fume hood exhaust system shall fail-safe.

B. Flow Rates

1. Fume hood systems and fans will be selected for a velocity of 100 FPM with the sash in a fully open position, with an exception for hoods requiring a greater face velocity. For hoods requiring a greater face velocity, fume hood systems will also be selected to provide the required face velocity with the sash in the fully open position.

2. The laboratories will have a minimum of 8 air changers per hour; auxiliary air for fume hoods is limited to a maximum of 50% of the required fume hood flow rate.

3. A minimum duct velocity will be provided through ductwork up to the exhaust fan for hoods requiring a face velocity of 100 FPM at any sash height. Minimum duct velocity must be calculated in accordance with the following standards/regulations for a face velocity of 100 FPM:
   a. ANSI Z9.5 Standard for Laboratory Ventilation


g. OSHA 29 CFR §1910.1450, Occupational Exposure to Hazardous Chemicals in Laboratories (Laboratory Standard).

h. Prudent Practices in the Laboratory.

4. The exit velocity from ductwork located on the building roof will be a minimum of 2000 feet per minute directed straight up from exhaust duct. The minimum exhaust duct height shall meet the most recent OSHA criteria (which is 7 feet).

C. Exhaust Fans

1. Fan installation in fan room lofts, attics, or rooftop penthouses. Each fan should be, in any case, the last element of the system so that the ductwork through the building is under negative pressure.

2. Ready access for fan maintenance shall be provided.

3. Fans should be provided with:
   a. outboard bearings, shaft seal, an access door;
   b. multiple 150 percent rated belts or direct drive;
   c. fan system shall be chemical resistant throughout and shall have a non-sparking wheel;
   d. in designing for explosion and fire control, the fan shall be of the non-sparking construction and the V-belt drive shall be conductive.

4. Vibration isolators shall be used to mount fan. Flexible connection sections of ductwork, such as neoprene coated glass fiber cloth, shall be used between the fan and its intake duct when such material is compatible with hood chemical use factors.

5. Each exhaust fan assembly must be individually matched (CFM, SP, BHP, etc.) to each laboratory hood and duct system design.

6. Choice of fan type will be determined as follows:
   a. use straight-radial fans for systems handling moderate to heavy quantities
of particulate matter in air;

b. use backward-curved fans for systems handling relatively clean (low particulate) air;

c. axial fans may be used in a vertical mounting for systems requiring washdown as perchloric acid hoods.

D. Perchloric Acid Fume Exhaust Systems

1. Perchloric acid deposits in hoods and ductwork are potentially explosive and, therefore, such systems must be considered to be hazardous. The following items shall be considered:

   a. each hood shall be provided with a separate fume exhaust fan and must be totally independent from any other exhaust and be located where a violent reaction will not harm adjacent equipment or personnel. Depending on the location, some type of protective screening may be desirable;

   b. hoods shall be located on the top floor to reduce to a minimum the extent of duct work required;

   c. ductwork must be welded type 316 stainless steel installed vertically from hood through fan to discharge with no elbows. All ductwork shall drain thoroughly fan casings and hood bottoms must be provided with continuous gravity drainage to the sanitary sewer;

   d. the entire system, including duct fans and hood, must be provided with an internal washdown system. The interior of the ductwork can be sprayed by various methods which must be reviewed with ASU prior to completion of the design. The washdown system shall be actuated by a manual valve located adjacent to the fume hood.

E. Hood locations and Disturbances

1. Cross drafts created by the room ventilation system, open windows, operable doors, personnel traffic, etc., can drastically disturb the flow of air entering the fume hood and cause a reverse flow of air out of the front of the fume hood. Room conditions such as these must be avoided by proper selection of ventilation delivery system, permanently locking windows, and locating hoods away from doors.

2. In no case should the velocity of cross drafts exceed 20 fpm or 20 percent of the hood face velocity adjacent to the hood.

3. Velocity of supply air shall be no more than 1/2 to 2/3 the face velocity, i.e., 50 to 70 fpm measured at the operator location in front of the hood while the hood is off and the sash open.
F. Noise

1. Noise measurements to be made at an average distance of one foot from the fume hood with the sash fully open using a type 2 sound level meter per ANSI S1.4-1971 and an octave band filter for 31.5 to 4000 Hz.

G. Make Up Air-General Laboratory

1. Air exhausted through laboratory fume hoods is not to be recirculated.

2. Positive pressure differentials shall be maintained between rooms to insure a positive air movement from clean to more contaminated areas. Therefore, air supply should exceed air exhausted to office or classroom space and air exhausted should exceed air supplied to laboratory space.

3. Laboratory units in which flammable materials are stored or used must maintain air negative to corridors or adjacent spaces.

H. Hood Utilities

1. Controls for hood utilities shall be located outside the hood including any three-pronged receptacles for 110 v power. Hood electrical switches shall have indicator lights. Indication lights shall be installed to indicate proper blower operation.

2. Hood lighting shall be vapor-proof or explosion proof, depending upon the intended purpose of the hood. Light bulbs should be changed from outside the hood.

3. Each sink or cup sink in a laboratory hood shall be individually trapped.

I. Storage

1. Underhood storage units intended for chemical storage shall minimally contain recessed floor, metal lining, liquid and gas-tight construction and ventilation flow from outside hood, through storage unit, to hood plenum chamber.

2. Underhood storage units intended for flammable liquids shall be ventilated and constructed to comply with the requirements of the Uniform Fire Code.

11 53 43 LABORATORY FIXTURES

Description

This section includes laboratory sinks for installation in tops and laboratory emergency plumbing fixtures. All fixtures shall comply with all applicable trade and building codes and regulations, as well as all applicable portions of the National Sanitation Foundation Standards.

Laboratory design and specifications must be developed with guidance from the
appropriate authority.

Design Standard

A. Cup Sink - Epoxy: Black, 3 inch x 6 inch oval with 1/4 inch raised lip at all hoods, as manufactured by Durcon, Epoxyn, or equal.

B. Cup Sink - Epoxy: Black, 3 inch x 6 inch oval flush with benchtop at areas other than Hoods, as manufactured by Durcon, Epoxyn, or equal.

C. Laboratory Sink - Epoxy: Black, at epoxy resin benchtops, size per Laboratory Furnishing drawings, as manufactured by Durcon, Epoxyn or equal.

D. Laboratory Sink - Stainless Steel: Integral with stainless steel benchtop and as specified in Section 12 35 53 and detailed on plans.

E. Animal Holding and Growth Room Sink - Stainless Steel: Manufacturer, Just or Elkay. Just #A47763 sink with J15FS drain and tailpiece and JS47TA-1 faucet with wrist blades.

F. Built In Cooktop: Manufacturer - General Electric Model JP65IJ with (2) 8 inch and (2) 6 inch electric heating units. Provide cooktop in brushed chrome finish - 208V, 1 phase, 5.5 amps.

G. Waste Disposer: Manufacturer - ISE model SS-75, 3/4 HP, 120V, 1 phase, 10 amps.

H. Other Materials: All other materials, fittings, and products required including stoppers, strainers, and tailpieces, shall be new suitable for location and function, and in compliance with accepted submittals. All strainers shall be mechanically fastened.

I. Angle Stops: Aquaflo ¼ turn ball valve style or equal.

J. P-Trap: Minimum size to be 1-1/2 inch diameter.

11 82 26 REFUSE COMPACTORS

General

A. Provide solid waste compactor system. Provide complete installation of compactor and associated controls. Refer to ASU Design Standards, Division 26 (Electrical) for general requirements of power and controls to meet ASU standards.

B. All items shall be stored in an enclosed shelter providing protection from damage and exposure to the elements.
Products

A. Compactor shall be sized by ASU and shall be as manufactured by Marathon, or equal.

B. Compaction cycle time shall be 30 seconds. Compactor shall automatically shut off and signal when container (bag if applicable) is full or when oversized or uncrushable objects are encountered. Access door shall be provided in side of hopper for manual feeding into compactor. Door shall be equipped with a shut off interlock to automatically prevent compactor from operating when door is open.

C. Compactor shall be capable of generating a minimum of 25,000 lbs. of compaction force at 2000 psi. Adjustable ram force shall produce compaction ratio of 5 to 1.

D. Control panel shall be mounted for ready accessibility on compactor or trash room wall and have the following: On/Off/Emergency Stop button and indicator lights for Power-On, Full Container, and Door Open.

E. Hydraulic cylinder shall be per model specified.

F. Compactor shall be constructed of heavy steel plate, welded and bolted together to form one continuous element.

G. Sides of compactor shall be fabricated from 3/16 inch steel plate and compactor and ram bottom plates from 3/8 inch abrasion resistant steel. Ram face shall be reinforced 3/8 inch steel plate and sides 3/16 inch steel. Hopper shall be fabricated from 12 gauge sides with 3/8 inch steel back plate. Abrasion resistant steel shall have a Birnell Hardness of 360.

H. Entire system shall be rust resistant primed and spray painted with an industrial grade enamel coating for resistance to damage or deterioration. Rough edges and weld splatter shall be ground smooth. Standard color shall be ASU Biege.

I. Containers shall be per ASU capacity and be fabricated from 12 gauge steel reinforced at all stress points. Containers shall have heavy duty ball bearing swivels with phenolic resin wheels. Wheels shall not be less than 6: diameter. Rear load containers shall have four swivel wheels. Front load containers shall have 4 swivel wheels.

J. Manually operated, lever actuated locking device shall secure container to both sides of compactor. Latching device shall be locatable on either side to permit container to be placed within 6 inch of wall opposite operator’s side.

Execution

A. All supplied items shall be installed in accordance with manufacturer’s current guidelines.

B. Additionally, ASU Grounds recommends that:
1. Drains be installed in the area, as well as hose bibs and lighting; 
2. Bollards be installed behind each box; 
3. Electrical outlets be installed for maintenance purposes; 
4. Boxes have an 8-cubic-yard capacity and be slant-topped to allow dumping by front-end loaders.
DIVISION 12 - FURNISHINGS

12 20 00 WINDOW TREATMENT

Description

This section applies to interior applications of window coverings of exterior windows. This section is considered the responsibility, both in design and project estimating, of the DP, not the IDC. All window openings other than lobbies or corridors shall have window coverings.

Design Standard

A. Interior window assemblies shall be designed to accept 2 inch vertical blinds or horizontal mini blinds, bead chain operated; full tilting operation with slats rotating 180º. Tilt operator control to be on the left hand side of the blind.

B. Blade thickness shall be 0.025 inch minimum, extruded solid polyvinyl chloride, with a 0.050 inch beaded edge.

C. A color should be specified that facilitates easy maintenance and will not yellow or fade when exposed to direct sunlight. ASU at the Polytechnic campus requires color to match window/door trim.

D. Acceptable manufacturers are Carey-McFall Corp., Graber Industries, Inc., Hunter Douglas, Inc., Levelor Lorentzen, Inc; or manufactures which have have equivalent quality.

12 35 53 LABORATORY CASEWORK AND BENCHTOPS

Description

This section applies to laboratory furnishings, casework, and tops. The work in this section requires close coordination with Divisions 22 and 26 in order to maintain orderly progress without removal of previously installed work, to prevent damage to finishes and products.

The use of modular or standardized, adjustable height lab benches are encouraged whenever possible to allow for reconfiguration.

Laboratory design and specifications must be developed with guidance from the appropriate authority.

Design Standard

A. One full-size sample of finished base cabinet unit complete with hardware, doors, and drawers; finished wall-mounted cabinet complete with hardware, doors, and adjustable shelves; hinged and sliding doors; and sink units and accessories are
required. Four samples of each type of specified finish and color are required.

B. All tops and casework of the same material shall be the product of a single manufacturer.

C. Benchtops:
   1. Molded epoxy resin tops shall be molded from a modified epoxy resin.
   2. Tops and curbs shall be a uniform mixture throughout their full thickness.
   3. Tops and curbs shall be non-glaring and black in color.
   4. Benchtops shall be 1-1/4 inch thick with drip grooves provided on the underside at all exposed edges. Further, all exposed edges, except as indicated below, shall be rounded to a 1/4 inch radius at front top edge and at vertical corners.
   5. Top set curbs at back and ends of benchtops shall be 4 inch high by 3/4 inch thick, bonded to the surface of the top to form a square joint.
   6. Sink cutouts shall be smooth and uniform without saw marks and the top edge shall have a uniform radius of approximately 1/8 inch.
   7. The bottom edge of the sink opening shall be finished smooth with the edge broken to prevent sharpness.
   8. Corners of sink cutouts shall be radiused not less than 3/4 inch.
   9. Indented bench tops shall be 1-1/4 inch thick at outer edge, indented 1/4 inch to provide a raised rim 1 inch wide around all exposed edges.
   10. The front top edge of the raised rim and exposed vertical corners of the top shall be rounded to a 1/8 inch radius.
   11. The juncture between the raised rim and the top surface shall be coved to a 1/4 inch radius.
   12. Physical Properties:
       a. Flexural Strength (ASTM Method 0790-71) - 15,000 PSI
       b. Compressive Strength (ASTM Method D695-77) - 35,000 PSI
       c. Hardness, Rockwell M (ASTM Method D78-65) - 100
       d. Water Absorption (ASTM Method D570-77)
       e. % by weight, 24 hours - 0.02
       f. % by weight, 7 days - 0.04
g. % by weight, 2 hour boil - 0.04

h. Specific Gravity - 1.97

i. Tensile Strength - 8,500 PSI

13. The benchtops shall be heat resistant and chemical resistant. Chemical resistance testing of the top may result in some discernible change in color or gloss, but no significant impairment of working surface function in life (an evaluation rating of "good" or better).

D. Metal Casework

All materials and methods used in construction shall conform to the best practices of the Scientific Laboratory Equipment Industry and Scientific Apparatus Manufacturers description.

1. Cold Rolled Sheet Steel shall be prime grade, roller leveled, and shall be treated at the mill to be free of scale, ragged edges, deep scratches, or other injurious effects. All gauges shall be U.S. Standard.

Metal Gages: 18 gauge, except as follows:

a. Corner gussets for leveling bolts and apron corner braces shall be 12 gauge.

b. Hinge reinforcements, case and drawer suspension channels shall be 14 gauge.

c. Top and intermediate front horizontal rails, table aprons, and reinforcement gussets shall be 16 gauge.

d. Drawer assemblies, door assemblies, and adjustable shelves shall be 20 gauge.

2. Hardware and Trim

a. Drawer and Door Pulls:

- Drawer and door pulls are to be of a clean, modern design offering a comfortable hand grip, and shall attach to door or drawer with machine screws on 4 inch centers.

- Pulls shall be of extruded aluminum coated with a clear, air-dry lacquer.

- Two (2) pulls shall be furnished on drawers wider than 28 inch. Use of plastic pulls or other types subject to breakage will not be accepted.
- Drawers shall be self-closing from a point 5 inches out from the closed position.

b. **Hinges:**

- Hinges shall be made of stainless steel with brushed satin finish, and shall be the institutional type with a five-knuckle bullet-type barrel.

- Hinges shall be attached to both door and case with two screws through each leaf. Welding of hinges to door or case will not be accepted.

- Doors under 36 inch in height shall be hung on one pair of 2-1/2 inch high hinges, and doors over 36 inch high shall be hung on 1-1/2 pair of 2-1/2 inch high hinges.

c. **Roll Point Catches:** Roll point catches for doors shall be cadmium plated steel with spring action.

d. **Elbow Catches** Elbow catches and strike plates shall be used on left hand doors of double door cases where locks are used, and shall be steel, socket and pin type.

e. **Shelf Adjustment Clips:** Shelf adjustment clips shall be nickel plated steel, socket and pin type.

f. **Leg Shoes:**

- Leg shoes shall be provided on all table legs, unless otherwise specified, to conceal leveling device.

- Shoes shall be 1-1/2 inch high and of a pliable, black vinyl material.

- Use of a leg shoe which does not conceal leveling device will not be acceptable.

g. **Support Struts:**

- Support struts shall consist of two 16 gauge channel uprights fastened top and bottom by two adjustable "U" shaped spreaders, each 12 gauge, 1-1/2 inch x length required.

- Struts shall be furnished to support drain troughs, and to support top at plumbing space under fume hood superstructures or other heavy loads.

- Support struts shall be furnished with hangers to support mechanical service piping and drainlines as shown on drawings. Support struts shall have a chemical resistant finish color.
h. Knee Space Service Strip Cover Panels:

- Shall be 18 gauge steel, of the same finish as cabinets, and shall be furnished at open spaces under counter top where no cabinets occur. They shall be easily removable and shall cover piping from underside of top of service ledge to floor.

3. Metal Casework Construction Performance:

a. Base cabinets shall be constructed to support a uniformly distributed load of 200 lbs. minimum per square foot of cabinet top area (total maximum of 2000 lbs.), including working surface without objectionable distortion or interference with door and drawer operation.

- Base cabinet corner gussets with leveling bolts shall support 500 lbs. per corner, at 1-1/2 inch projection of the leveling bolt below the gusset.

- Each adjustable and fixed shelf 4 ft. or shorter in length shall support an evenly distributed load of 40 lbs. per square ft. up to a maximum of 200 lbs., with nominal temporary deflection, but no permanent set.

- Drawer assemblies shall automatically maintain alignment in cabinet opening and shall not bind during opening or closing of the drawer so as to minimize glass breakage and damage to fragile parts.

- Swinging doors mounted on base units shall support a 250 lb. load located at a test point of 14 inch measured horizontally front hinge along the top edge of door through a swing of 180 degrees. Weight test shall allow nominal temporary deflection, but no permanent distortion. Door assembly shall be twist-resistant and rigid, and shall close in a flat plane against the cabinet to permit the door catch at top of door to function properly.

4. Metal Casework Finish Requirements:

a. The completed finish system shall be certified to have no other effect other than slight discoloration, decrease in gloss or temporary slight softening of the finish film with no loss of adhesion and film protection as a result of chemical spot tests.

5. Acid Storage Base Cabinets:

a. Acid storage cabinets shall utilize the same gauges of metal and construction features as specified for other base cabinets above except that they shall be completely lined with a corrosion resistant liner.
b. A one-half width removable shelf of the same material as the liner shall be furnished with each cabinet.

c. Where specified, each cabinet shall be vented up as shown on drawings above the cabinet with a 1-1/2 inch PVC vent pipe. The bottom end of the vent pipe shall project through the back panel of the cabinet. The top end of the vent pipe shall be level to dished top, behind baffle in hood.

d. Provide 2 inch deep polypropylene pans to cover entire bottom of cabinet. Label cabinet "Acid Storage." Lettering size and style to match labeling of other special purpose metal cabinets.

6. Solvent Storage Base Cabinets:

   a. Solvent storage cabinets shall be specifically designed for the storage of flammable and combustible liquids. Construction shall be based upon the requirements listed by OSHA and NFPA No. 30, current edition, and cabinets shall be Factory Mutual approved and labeled.

   b. The bottoms, top, sides, and doors shall be fabricated of 18 gauge steel and shall be all double panel construction with a 1-1/2 inch air space between panels. All joints shall be welded, or screwed, to provide a rigid enclosure.

   c. The doors shall swing on full length piano hinges and shall be fully insulated and self closing. The right hand door shall be equipped with a three point locking device and the left hand door shall have a full height astragal.

   e. A 2 inch deep liquid tight pan that covers the entire bottom of the cabinet shall be furnished to contain liquid leaks and spills.

   f. The shelves shall be heavy duty and shall be reinforced at all edges and down the center on the underside.

   g. A grounding screw shall be provided at the back bottom corner.

   h. The cabinet shall be completely finished both inside and outside with a paint finish that will meet the finish requirements of other metal casework above.

   i. The cabinet shall be labeled in conspicuous lettering - "Flammable - Keep Fire Away." Lettering size and style to match labeling of other special purpose metal cabinets.

   j. Cabinet shall be vented as shown on drawings with 1-1/2 inch IPS threaded vents with flame arrestors. Bottom end of the vent pipes shall project through the back panel of the cabinet. The top end of the vent pipes connect into the hood exhaust system above the fume
k. At cabinets located remote from fume hood, vent pipe shall rise up in partition construction to make connection with fume exhaust system.

E. Stainless steel for benchtops, sinks, and acid soak tank shall be Type 316 and shall be of gauge indicated on drawings or specifications.

1. Autoclave enclosures, drying racks, canopy hoods, slotted exhaust and shelves shall be type 304 stainless steel.

2. All fabrications shall have exposed surfaced ground and polished to a #4 satin finish.

3. All stainless steel nuts, screws, bolts, and rivets, etc., shall be of the same type stainless as in the sheet material and shall have a tumbled finish closely resembling that of a #4 finish.

F. Stainless steel tops shall be 16 gauge.

1. Stainless steel sides and backsplashes shall be integrally welded to top.

2. Tops with sinks shall be fabricated with a marine edge and pitched to sink board for proper drainage. Marine edges shall be seamless die-formed.

3. All stainless steel sinks shall be Type 316, 16 gauge. All sink joints shall be butt welded and ground smooth.

4. Underside of sink shall have a heavy mastic agent coating providing sound deadening.

12 50 00 FURNITURE SELECTION

Description

For classrooms and instructional spaces, see the Classroom Design Guidelines, provided by the Office of the University Architect (OUA). This section applies to seating, computer work stations, and the selection of other non-academic furniture. ASU strongly recommends the DP utilizes the expertise of an Interior Design Consultant in the programming phase to evaluate project furniture needs.

Capital Programs Management Group shall be provided a physical sample of each furniture item proposed for testing and approval. The DPM will be responsible to obtain user group and any other approvals as required on a project by project basis.

12 50 00.01 CLASSROOM WORKSURFACES

For classrooms worksurfaces standard, see the Classroom Design Guidelines, provided by the Office of the University Architect (OUA).
12 50 00.02 SEATING

Seating is an obvious contributing factor to overall comfort. Therefore, seating should be selected that will meet minimum comfort standards and still satisfy the requirements of Uniform Building/Fire Codes, cost, durability, functional comfort, appearance/finish, and performance over time.

This standard for seating does not include classrooms, classroom auditoriums, or lecture halls. For classrooms, auditoriums or lecture hall standards, see the Classroom Design Guidelines, provided by the Office of the University Architect (OUA).

Design Standard

A. Aspects to be considered when selecting seating in order to achieve minimum standards of comfort:
   1. Width of seat
   2. Type of Lumbar support in back
   3. Appearance
   4. Versatility of seating
   5. Replacement availability/Ease of maintenance
   6. Cost

B. Seating Width
   1. Minimum comfort will range from 18 inch minimum to 22 inch maximum.
   2. The selection of seating width should be based upon the criteria set forth for the type of seating utilization described in the width selection matrix.

C. Seating Back Support
   1. All seating shall have proper lumbar support.
   2. The back should have a slope ranging from 12 to 30 degrees for classroom seating.
   3. The height of the back should not exceed 34 inch from the floor level.

D. Appearance
   1. The appearance shall be coordinated with the interior of the classroom and meet the acoustical requirements for the space.
   2. Soft coverings shall be used in large auditoriums or lecture halls where reverberation of sound is a problem.
   3. The construction and materials should be selected so that their color and surface are consistent with the other furnishing within the classroom.

E. Replacement Availability/Ease of Maintenance
1. Chairs shall be procured from manufacturers that demonstrate proven track records in the marketplace, and maintain stock levels that insure replacement can be made without timely backorder delays.

2. Chairs shall be selected that facilitate cleaning of the floor surface, and require minimum maintenance of the seat covering (if applicable).

F. Cost

1. High quality seating shall be purchased to minimize the long term life cycle costs since funding for equipment replacement, repair, and maintenance are becoming increasingly difficult to obtain.

12 50 00.03 COMPUTER WORKSTATIONS

Description

Computer workstations should be provided that will meet the demands of the equipment, plus the necessary space for student materials. See the Classroom Design Guidelines, provided by the Office of the University Architect (OUA) for more information.

Design Standard

A. Allow for a minimum surface area of six and one quarter (6.25) square feet to be provided.

B. Furniture selection for computer workstations shall have provisions for securing the equipment and the furniture in the room.

C. Additional ventilation is required if white marker boards are utilized due to marker fumes.

D. Provisions for electrical fires should be considered for areas with computer workstations.

12 50 00.05 TEACHING LABORATORIES

Description

The following Teaching Lab Standards provide a generic overview of the situation encountered at Arizona State University. This section contains information of importance to the mechanical and electrical design. Ensure that this section is referenced in the appropriate divisions and sections. The standards are organized into three sections:

Section B covers the linear feet per section, minimum and maximum services per station, square feet per station and per student. Section C covers fume hood linear footage and services. Section D covers sinks and support space.
Teaching labs have unique requirements and the user must be consulted to establish requirements. Obviously, any particular laboratory design project would require specific study in order to determine whether a modification to these generic standards is required.

**Design Criteria**

A. Laboratory Types
   1. B1 - Dry Lab with No Fume Hoods or Support Space Use
   2. B2 - Dry Lab with No Fume Hoods Use but Support Space
   3. C1 - Wet Lab with No to Low Fume Hoods Use with Support Space
   4. C2 - Wet Lab with Medium Fume Hood use with Support Space
   5. C3 - Wet Lab with High Fume Hood Use with Support Space

B. Linear Feet per Section, Minimum and Maximum Services per Station, Square Feet per Stations and per Student.

<table>
<thead>
<tr>
<th>ROOM</th>
<th>Linear per Min</th>
<th>Minimum Services Per Station</th>
<th>Maximum Services Per Station</th>
<th>Square Feet per Station Min</th>
<th>Max</th>
<th>Square Feet per Student Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>B1: Dry Lab</td>
<td>3.5-4.5</td>
<td>2-120V-15A</td>
<td>2-120V-20A G, LA, CW</td>
<td>17.5</td>
<td>25</td>
<td>42</td>
<td>55</td>
</tr>
<tr>
<td>B2: Dry Lab</td>
<td>3.5-4.5</td>
<td>2-120V-15A</td>
<td>2-120V-20A G, LA, CW</td>
<td>17.5</td>
<td>25</td>
<td>42</td>
<td>55</td>
</tr>
<tr>
<td>C1: Wet</td>
<td>3.5-4.5</td>
<td>2-120V-15A</td>
<td>2-120V-20A G, LA, CW</td>
<td>17.5</td>
<td>25</td>
<td>42</td>
<td>55</td>
</tr>
<tr>
<td>C2: Wet</td>
<td>4-6.5</td>
<td>2-120V-15A LV, LA, CW</td>
<td>2-120V-20A G, LA, CW</td>
<td>20</td>
<td>32.5</td>
<td>42</td>
<td>55</td>
</tr>
<tr>
<td>C3: Wet</td>
<td>6-8</td>
<td>2-120V-15A LV, LA, CW</td>
<td>2-120V-20A G, LA, CW 1/2 main sink</td>
<td>20</td>
<td>32.5</td>
<td>42</td>
<td>55</td>
</tr>
</tbody>
</table>

D. Fume Hood Linear Footage and Services

<table>
<thead>
<tr>
<th>ROOM</th>
<th>LF/Station or Min</th>
<th>Minimum Services Per Station</th>
<th>Maximum Services Per Station</th>
</tr>
</thead>
<tbody>
<tr>
<td>B1: Dry Lab</td>
<td>0-0</td>
<td>1-120V-15A LA, CW cupsink</td>
<td>2-120V-20A LA, CW cupsink</td>
</tr>
<tr>
<td>B2: Dry Lab</td>
<td>0-0</td>
<td>1-120V-15A LA, CW cupsink</td>
<td>2-120V-20A LA, CW cupsink</td>
</tr>
<tr>
<td>C1: Wet</td>
<td>6' 6'</td>
<td>1-120V-15A LA, CW cupsink</td>
<td>2-120V-20A LV, LA, CW</td>
</tr>
<tr>
<td>C2: Wet</td>
<td>1'/10</td>
<td>1-120V-15A LA, CW cupsink</td>
<td>2-120V-20A LV, LA, CW</td>
</tr>
<tr>
<td>C3: Wet</td>
<td>2'/1 5'/1</td>
<td>1-120V-15A</td>
<td>2-120V-20A</td>
</tr>
</tbody>
</table>
E. Sinks and Support Space

<table>
<thead>
<tr>
<th>ROOM</th>
<th>Fraction Per Min</th>
<th>Minimum Services Per Station</th>
<th>Maximum Services Per Station</th>
<th>SF Support Per Student</th>
<th>Support Services</th>
</tr>
</thead>
<tbody>
<tr>
<td>B1: Dry Lab</td>
<td>1/18</td>
<td>HW, CW 18&quot; x 24&quot; sink</td>
<td>HW, CW 20&quot; x 36&quot; sink</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B2: Dry Lab</td>
<td>1/12</td>
<td>HW, CW 18&quot; x 24&quot; sink</td>
<td>HW, CW 20&quot; x 36&quot; sink</td>
<td>8</td>
<td>25</td>
</tr>
<tr>
<td>C1: Wet</td>
<td>1/4, 1/1</td>
<td>HW, CW, DW 18&quot; x 24&quot; sink</td>
<td>HW, CW, DW 12&quot; x 18&quot; sink</td>
<td>7</td>
<td>14</td>
</tr>
<tr>
<td>C2: Wet</td>
<td>1/4, 1/1</td>
<td>HW, CW, DW 18&quot; x 24&quot; sink</td>
<td>HW, CW, DW 12&quot; x 18&quot; sink</td>
<td>7</td>
<td>14</td>
</tr>
<tr>
<td>C3: Wet</td>
<td>1/8, ½</td>
<td>HW, CW, DW 20&quot; x 36&quot; sink</td>
<td>HW, CW, DW 12&quot; x 18&quot; sink</td>
<td>7</td>
<td>14</td>
</tr>
</tbody>
</table>

12 93 00 SITE & MALL FURNISHINGS

Description

This section applies to all furnishings exterior to the main confines of a building or exterior plazas, atriums and entry features. Features shall conform to the standards of this section, and where additional items are proposed but not included in this sections, they shall be submitted to the ASU University Architect and the DRB for review and approval at the completion of the schematic design phase.

If additional items are approved for a specific projects, then Supplier information and Specifications (including description, size and color of items) shall be furnished to ASU Grounds Services.

Design Standard

A. Trash Receptacles

1. Shall be an exposed aggregate cylindrical shape, 40 inches tall, 18 inch diameter, manufactured by Wausau Tile, tan in color.

B. Cigarette Urns

1. Shall match the trash receptacles in material, finish and color and shall be 24 inches high, 14 inch diameter, manufactured by Wausau Tile.

C. Mall Benches

1. Reinforced concrete. length 7'-10", height 2'-10", depth 2'-3"; light beige color.
of 1-1/2 inch San Diego Buff, sealed with Thompson water sealer; sack smooth finish (see sketch).

D. Signs

1. Exterior building signs are manufactured by the ASU Sign Shop and are installed by ASU Grounds Services. Information to the Shop shall include the building name, colleges (main office) and prime functions. The sign is deep brown in color, 48 inch high, 33 inch wide with 3-1/2 inch capped end posts. The panel is 24 inch x 32 inch, with 2 inch and 1 inch lettering.

E. Bicycle Racks

1. Bicycle racks are “owned” by Parking & Transit Services (PTS).
   a. The racks shall be hot dipped galvanized original factory material. Prior to delivery to the jobsite, the rack must be factory finished as follows:
      - Sandblasted, cleaned, prepped and coated with three mils, minimum of fusion bond polyester powder;
      - Manufacturer/color to be Morton Thiokol "mineral bronze" number 33-9012, or equal;
      - Coating to be fused by 101-9 process at maximum 500 degrees Fahrenheit;
      - Racks are to be delivered to factory without primers, fillers, gaskets or other non-metal materials not capable of withstanding oven temperatures of 500º F;
   c. The bronze color specified above is common to all of the mall amenities on the campus;
   e. The coating is an electrostatic factory-applied process. Field application is not acceptable without prior approval.
   f. Bike rack pods must be well away from building entrances, wheelchair ramps, and existing or future dismount zones. Pods must be located in open, public places that are well frequented by the public and police patrols. Good lighting is also required.
   g. Racks must be spaced according to the following minimum requirements:
      - 2' between the side of a rack and any adjacent wall;
      - 2' between the end of a rack and any adjacent wall;
      - 2' between the end of a rack and the end of any adjacent bike rack;
      - 7' between the side of a rack and any adjacent bike rack;
No racks may be placed where they will come between any doorway and the mall or street on which the building is located, and;

- the average space requirement for each rack is 85 square feet; minimum pod size is 8 racks or 80 spaces.

h. Contractors are to deliver the racks to the approved site; and ASU Grounds Services will do the actual installations, unless a prior agreement has been reached.

i. All plans that involve bike racks, parking pods, bike paths, or other traffic related concerns must be approved by the ASU Department of Public Safety and must adhere to recommendations in the Campus Transportation Master Plan and those of Parking & Transit Services.

F. Tables

1. Tables shall be provided where the DP may feel the design or surrounding features warrant such use. The same durability and simplicity in the design as the mall benches (see sketch).
DIVISION 13 - SPECIAL CONSTRUCTION

13 12 00  FOUNTAINS & WATER FEATURES

Description

This section addresses features in or around a project that utilize water as means of acoustic, aesthetic or micro-climate control features. In general, the use of water features are highly discouraged on Campus due to their poor record of performance, constant high maintenance and water conservation measures adopted by ASU and the State.

Design Standard

A. Not acceptable on campus unless specific approval is obtained.
DIVISION 14 - CONVEYING EQUIPMENT

14 20 00 ELEVATORS

Description

This section applies to the design and installation of passenger elevators. There shall be a minimum of 2 elevators for any building over one story, regardless of floor area or building type. Where one elevator is used, it shall also be designed for occasional use as a freight elevator. In designing multi-elevated buildings, at least one car shall be designated for full time use for freight. The DP shall supply prior to the completion of the schematic design phase, a signed analysis from a certified elevator supplier regarding the number of recommended elevators, types and speeds, for the project.

Proprietary control equipment will not be acceptable. Electronic controls will require that all manuals, control diagrams, and operating information shall be supplied, along with "The Tool" with password instructions, to the owner. All PC boards and components shall be available to the Elevator Contractor holding the owner’s blanket service contract, in a timely manner as well.

No system will be installed that does not meet this requirement, and will be replaced at the expense of general contractor if installed and determined after installation to be proprietary in any way.

All controls be designed and provided by either Motion Control Engineering, Inc. (MCE) or other company who supplies nonproprietary control equipment for the elevator industry. All others shall be approved by ASU Elevator Contract Administrator.

All ADA handicap standards will be observed in design and installation. ADAAG, ANSI A117.1, UFSA NE Handicap standards 4th edition July 1985 and ASME A17.1 – 1996 will be met or exceeded.

Electronic Door edges will be provided on all elevators.

Cab lighting shall be on emergency power or secondary power supply at ASU at the Tempe campus (battery backup will not be accepted). At ASU at the Polytechnic campus, no centralized emergency power is available, therefore, cab lighting by battery backup will be accepted.

Traveling cables shall contain 6-conductor, 2 shielded twisted pairs for security card readers.

Design Standard

A. General

1. Power supply to be 480Y/277 volts, 3 phase/60 cycle, 4 wire grounded system.

2. A fire recall system should be provided for all elevators. Where fire sprinklers
are installed in elevator shafts or machine rooms, a shunt trip breaker will be installed to separate all power from the elevators. This shunt trip will be operated by the fire alarm panel using a heat detector (not smoke) installed in the elevator shaft and in the machine room, per State Elevator Inspector. Any special fire protection systems (detection or suppression) for elevators must be connected to the building fire alarm systems that reports to ASU Dispatch.

All elevator fire recall switches shall be operated by the ASU Medeco Key A2-C (both inside the elevator and in the main lobby control switch). Fire recall switch shall override the normal custodial service switches but not the maintenance shutdown switches.

All special functions (air handler shutdown, fire and/or smoke door operation, fire dampers, audible alarms, visual alarms, elevator recall, smoke control systems and vents, fire curtains, the connection to ASU Police Services Dispatch, and special suppression system activations) must be designed to be bypassed by a supervised deactivating device or keyed switch. The audible and visuals must be designed so that it can be disabled without effecting any other special functions. All deactivating devices must be at the panel and designed in a manner that will not require any tools. An access code that is supervised or a keyed (ASU A, B key) operation that is supervised shall be used.

3. On geared machines, provisions shall be made to manually bring car to floor level in case of complete power failure.

4. Machinery spaces shall be located to minimize vibration and noise, and be fully sound attenuated.

5. All wires in the travelling cables shall be terminated on a terminal board with permanent identification matching that used in schematic diagrams.

6. All relays, switches, resistors, overload devices, fuses, timers, etc., mechanically or electrically operated, shall be permanently marked with identification matching the shop drawings.

7. All field wiring must terminate at each control cabinet on properly identified terminal strips. Field wiring shall not terminate on equipment or relay studs. All control wiring shall be of stranded construction.

8. Temperature rise in windings shall not exceed 50°C above ambient in all testing modes.

9. All machinery rooms, where mechanical and electrical equipment is located, shall have a separate and independent air conditioning system installed. A chilled water system is preferred but must run independent of the building system. Air conditioning equipment shall be designed for a 72 degree indoor temperature/110 degree outdoor temperature. Machinery rooms shall maintain 75 degrees in the cooling mode. Heating is not required.
**B. Hydraulic**

1. Hydraulic elevators shall be piston type, limited to a maximum of 3 stories; 4,000 lbs. minimum capacity; 200 fpm minimum speed;

2. Car size clear dimension 5'-8" wide, 8'-9" deep, fully handicapped accessible.

3. Machine room located adjacent to first car stop if possible.

4. Hoistway doors shall be 4’ wide x 7’ high; 2 speed side opening; direct current powered.

**C. Traction**

1. Traction elevators (with variable speed drive) shall be used for buildings 4 floors or more; 4,500 lbs. minimum capacity; 350 fpm minimum speed; microprocessor controlled.

2. Car size clear dimension 5'-4" wide, 8'-5" deep, fully handicapped accessible.

3. Hoistway doors shall be 4’ wide x 7’ high; 2 speed side opening; direct current powered, unless it is designed for freight usage in which the door opening shall be a minimum of 54 inches wide.

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**14 27 00  PASSENGER CABS - INTERIOR**

**Description**

This section applies to the interior furnishing and finish of all passenger elevator cabs, regardless of whether they be hydraulic or traction type.

**Design Standard**

A. Floor identification numbers shall include braille adjacent to control buttons and be a height from the floor that allows full floor button reach to the handicapped (hgt. to be determined by ASU disabled Student Resources prior to schematic design completion).

B. Car and hall buttons to be illuminated; car position and travel signaled by lantern and gong.

C. Lighting and signals shall be tamper/vandal-proof for both the cab and call stations.

D. Each car shall have a tamper-proof auto dialing K-telephone, reporting back to ASU Police Services Dispatch.

E. Walls shall be plastic laminate of a color that facilitates easy maintenance.

F. The canopy and sills shall be extruded aluminum.
G. The interior door front and transom shall be #4 finished stainless steel with front return and swing panel.

H. The exterior surface of doors (room side) and entrance frames shall be baked enamel, finish with #4 stainless steel returns and trim.

I. Ceilings shall be suspended, tamper/vandal resistant, minimum height 8'-6"; lighting to be fluorescent fixtures supplying an average car lighting level of 30 footcandles.

J. Floors shall be hard surfaced (rubber, tile, vct, or equivalent etc.). Hard rubber flooring is to be Roppe hard rubber tiles, 22-1/2 inch by 22-1/2 inch.

K. Finish surfaces should be demountable or be fitted with brackets or holders to receive a protective blanket to protect surface when on and off loading material.

L. All elevator cabs shall be supplied (stored when not in use) with an appropriate number of protective blankets.

M. Each cab shall be supplied with 3 side continues stainless steel handrail, #4 finish; emergency lighting and two speed exhaust fan.

N. Elevator shaft pit shall have a sump pit 18 inch x 18 inch x 12 inch. Provide pit with sump pump and holding tank. If hydraulic elevator, holding tank shall be large enough to hold all hydraulic fluid plus 25% of capacity of tank.
DIVISION 21 - FIRE SUPPRESSION

21 10 00 FIRE PROTECTION SYSTEMS

All current NFPA codes and standards shall apply with the exceptions noted below

A. Acceptance

1. Prior to any test by ASU and/or the Authority Having Jurisdiction (AHJ), a complete system with no troubles or alarms (Green Panel) must be confirmed. Testing will be at the discretion of the State Fire Marshal and/or the ASU Fire Marshal in conjunction with the fire testing crew. A stamped/approved plan by the Authority Having Jurisdiction (AHJ) must be on site to review for testing and any alterations to approved plans must be hand written on the plans. AHJ is the immediate and legal government fire safety professional.

2. A copy of “as-built” drawings shall be provided by the contractor prior to the scheduled time of test to be kept and used by our department at their discretion. In addition, a digital set of as-built sprinkler system plans shall be provided and shall include information for every individual sprinkler head location, which identifies the manufacturer, model, temperature rating and date of manufacture for the head that was actually installed. In addition, a digital summary shall also be provided which lists all the individual types of heads installed for the whole building, and the total number installed of each type. It is the responsibility of the sprinkler contractor to verify in the field that the inventory accurately represents the heads that were actually installed. Reliance solely on the approved shop drawings is not acceptable.

3. A complete, accurate and up-to-date points list shall be provided (hard copy and digital) by the fire alarm contractor prior to the time of test showing each device address, type and location to be kept and used by our department at their discretion.

4. All trades involved with the fire alarm system (including but not limited to: building contractor, fire alarm contractor, elevator contractor, electrical contractor, mechanical contractor, fire sprinkler contractor, etc.) shall be present at scheduled time of acceptance test to provide all necessary time and material to test each and every individual device involved in the proper operation of the fire alarm system. Tests are conducted to confirm all required functions/operations of the system are compliant prior to final AHJ acceptance test.

5. It is recommended a five-day notice prior to scheduling of acceptance test to alleviate the scheduling conflicts involved in allocating time to prepare and conduct such test.

6. A valid work order number with funds is necessary to cover the time and material involved in conducting the 100% acceptance inspection test.
B. Materials
   1. Schedule 40 seamless black steel pipe will be the minimum acceptable material.
   2. All schedule 40-grooved pipe shall be roll grooved, no grooving that removes material from the pipe shall be allowed.
   3. No plastic pipe of any type may be used on any fire protection system.
   4. Hooking collar assemblies shall not be used for connecting sprinklers or drop nipples to sprinkler pipe.

C. Design standard
   1. In buildings with sprinklers, fire pumps and/or standpipes, separate water service for fire protection shall be provided, and shall not be through the domestic metered water service.
   2. In all buildings, other than the branch lines protecting such equipment, no mechanical joints will be allowed in electrical or communications equipment rooms. If piping must pass thru, then all joints shall be welded.
   3. In all buildings with fire alarm systems, all control valves, including post indicator and wall indicator valves, shall be electrically supervised by the fire alarm panel. At all locations that control valves are concealed above ceilings or behind access doors, a sign shall be provided on the ceiling below the valve or the access door indicating the location of the control valve. In residential buildings, all control valves that are located in spaces accessible by the occupants of the building shall be provided with lockable tamper prevention devices and locks (that shall be specified by the University). Control valves shall only be installed in corridors, stairwells, mechanical rooms, fire pump rooms and sprinkler valve rooms and shall be easily accessible. The control valves shall be accessible with the use of no more than a six-foot stepladder. Provide 24” x 24” access door for valves located above inaccessible ceiling types. Control valves shall not be installed, above or below ceilings in classrooms, offices, conference rooms or any dormitory living quarters. Each control valve shall be supplied with a sign indicating the area of the building that is served by the valve.
   4. At all locations that inspector test valves (ITV) are concealed above ceilings or behind access doors, a sign shall be provided on the ceiling below the valve or on the access door indicating the location of the ITV. Inspector test valves shall only be installed in mechanical rooms, corridors, stairwells, fire pump rooms, sprinkler valve rooms and custodial closets and shall be easily accessible. The ITV’s shall be accessible with the use of no more than a six-foot stepladder. Inspector test valves shall not be installed, above or below ceilings, in classrooms, offices, conference rooms or in dormitory living quarters or in any area requiring entry through a classroom, office, conference room or any dormitory living quarters. Inspector test valves
discharge shall be piped to a drain capable of handling the discharge at full flow or to the exterior of the building.

5. Drain valves shall only be installed in corridors, stairwells, mechanical rooms, fire pump rooms and sprinkler valve rooms and shall be easily accessible. The drain valves shall be accessible with the use of no more than a six-foot stepladder.

6. Drain valves shall not be installed, above or below ceilings, in classrooms, offices, conference rooms or in dormitory living quarters, or in any area requiring entry through a classroom, office, conference room or any dormitory living quarters.

7. Main drains discharge shall be piped to the exterior of the building. Auxiliary drain valves discharge shall be piped to a drain capable of handling the discharge at full flow or to the exterior of the building.

8. All ITV’s and drains piped to the exterior shall drain onto a splash block and be in such a location as to not flood sidewalks and malls, building entrances or any location that will disrupt normal pedestrian traffic.

9. No sprinkler heads from any manufacturer, which incorporate a rubber O-ring, shall be permitted to be installed in university buildings. If a unique situation exists where a head with a rubber O-ring is the only type that will work, specific permission to use the head must be obtained from the university on a case-by-case basis.

D. Drawings

1. One "as built" drawing shall be supplied for Capital Programs Management Group’s Print Room.

2. All fire protection systems as shall be identified in AutoCAD on floor plans. ASU must be supplied with one hard copy and a CD, identifying the locations of every item on the legend that follows.
DIVISION 22 - PLUMBING

22 05 00  GENERAL PROVISIONS

Description

The utility services for the ASU at Tempe campus are from a Central Utility Distribution System, which includes chilled water, steam, domestic hot water, distilled water, primary electrical power, and emergency power systems via a tunnel system. Contact Capital Programs Management Group regarding utility services at the various campuses.

All new buildings and building expansion projects shall utilize central utility services, if available. It is imperative that building utility requirements be calculated at the programming or schematic design submittals to assure adequate services are available at anticipated connection points. Refinement is expected as design progresses and shall be finalized at the design development stage, with final interconnection requirements identified.

Design Standard

A. Domestic hot water is available in certain segments of the tunnel system at ASU at the Tempe campus; consult the tunnel distribution system drawings for availability. If not available, utilize a steam/domestic hot water heater for domestic hot water needs.

B. Type III ionically pure reagent water is available in certain segments of the tunnel system at ASU at the Tempe campus; consult the tunnel distribution system drawings for availability if needed for building use.

C. Potable water at ASU at the Tempe campus is available in the two separate systems: The campus potable water system distribution (generally in tunnels at ASU at the Tempe campus) or the City of Tempe water distribution (basically in abandoned streets). Depending on proximity of the facility and water use requirements, either system may be used. Contact Capital Programs Management Group for information regarding potable water at the various campuses.

D. All utility services shall be metered.

E. The sanitary sewer system at ASU at the Tempe campus exists along all malls and abandoned streets on campus; peak and average flow requirements shall be calculated to determine adequacy of potential tie-in points. Contact Capital Programs Management Group for information regarding sanitary sewer at the various campuses.

F. For new or tie-in to existing tunnel utility source at ASU at the Tempe campus, Contact Capital Programs Management Group. All new tunnels shall be as wide as possible with a minimum walking clearance of 3'-0". All connections to existing systems shall not obstruct walking clearances. All tie-ins shall have a valve at the connection point accessible for operation.
G. All tie-ins to utilities shall be coordinated through Capital Programs Management Group.

H. Equipment requiring OEM parts is not desirable.

CODES

A. Include without additional cost to owner all labor, services, apparatus and drawings required to comply with applicable laws, ordinances, rules and regulations.

B. Applicable mechanical, electrical, gas, plumbing, health/safety and sanitary codes, laws and ordinances:
   - Underwriter's Laboratories, Inc. Standards
   - American Society for Testing Materials Standards
   - Uniform Plumbing Code
   - National Fire Protection Association Standards
   - Factory Mutual Standards

PRODUCTS

Materials and equipment shall be standard products of a reputable manufacturer regularly engaged in manufacture of the specified items. Where more than one unit is required of any item, furnish by the same manufacturer except where specified otherwise. Install material and equipment in accordance with manufacturer’s recommendations.

VALVES (PLUMBING)

On domestic water, no sweat connection valves shall be used. Use only flanged or threaded valves.

Include sufficient zone isolation/shut off valves in cold/hot water piping to allow maintenance and replacement of terminal equipment without shutting down entire building.

Install valves on lines that penetrate the floor from below.

Install valves on all branch lines off of the main lines.

Install valves on all lines at locations such that each floor can be isolated independent of main building.

MECHANICAL ROOMS, SERVICE CLOSETS AND EQUIPMENT LOCATIONS

Provide adequate safe access and manufacturer’s recommended working clearances for all equipment.

Provide for replacement of the largest pieces of equipment without removing permanent walls, large items of equipment or equipment essential to the principal on-going day to day building use.

Provide direct access from the exterior for major mechanical rooms exceeding 100 net
square feet.

In phased projects, mechanical rooms shall be sized to include equipment for all the phases.

Mechanical rooms shall have a floor drain.

Service closets shall be designed to adequately accommodate the portable equipment required to service the building (i.e. custodial equipment).

EXISTING INSTALLATIONS AND CONFLICTS

Protect existing active services (water, gas, sewer, electric, etc.), when encountered, against damage from construction work.

NAMEPLATES AND CODING

Identify all items of mechanical equipment by approved nameplates. Approved nameplates shall be engraved laminated plastic with white lettering and black background. Lettering/numbering will be no less than 3/4" in height. Nameplates exposed to sunlight will be made of UV resistant material. Secure nameplates to each individual piece of equipment.

The identification shall correspond to the designation used on the construction drawings, and shall include, but not be limited to, the following:

1. Pumps
2. Water heaters
3. Heat exchangers
4. Tanks
5. Receivers
6. Water softeners
7. Water skills

Identify piping according to ANSI A13.1 standard for pipe identification (see next page).
# ANSI A13.1
## PIPE IDENTIFICATION STANDARD

<table>
<thead>
<tr>
<th>Material Properties</th>
<th>Letter Color on Field Color</th>
</tr>
</thead>
<tbody>
<tr>
<td>INHERENTLY HAZARDOUS MATERIALS</td>
<td></td>
</tr>
<tr>
<td>Extreme Pressure or Temperature</td>
<td>BLACK ON YELLOW</td>
</tr>
<tr>
<td>Radioactive</td>
<td></td>
</tr>
<tr>
<td>Corrosive or Caustic</td>
<td></td>
</tr>
<tr>
<td>Toxic or Creates Toxic Gas</td>
<td></td>
</tr>
<tr>
<td>Extreme Pressure or Temperature</td>
<td></td>
</tr>
<tr>
<td>Explosive or Flammable</td>
<td></td>
</tr>
<tr>
<td>LOW HAZZARD MATERIALS</td>
<td></td>
</tr>
<tr>
<td>Liquid or Liquid Mixture</td>
<td>WHITE ON GREEN</td>
</tr>
<tr>
<td>Gas or Gaseous Mixture</td>
<td>WHITE ON BLUE</td>
</tr>
<tr>
<td>MATERIALS FOR FIRE SUPPRESSION</td>
<td></td>
</tr>
<tr>
<td>Sprinkler Water, Carbon Dioxide, Foam, Halon, etc</td>
<td>WHITE ON RED</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Outside Pipe Diameter Including Covering</th>
<th>Minimum Length of Label Field Color</th>
<th>Minimum Height of Letters</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inches</td>
<td>mm</td>
<td>Inches</td>
</tr>
<tr>
<td>----------------</td>
<td>-----------------</td>
<td>-----------------</td>
</tr>
<tr>
<td>3/4 to 1</td>
<td>19 to 32</td>
<td>8</td>
</tr>
<tr>
<td>1/4</td>
<td>38 to 51</td>
<td>8</td>
</tr>
<tr>
<td>1 1/2 to 2</td>
<td>64 to 152</td>
<td>12</td>
</tr>
<tr>
<td>2 1/2 to 6</td>
<td>203 to 254</td>
<td>24</td>
</tr>
<tr>
<td>8 to 10</td>
<td>over 254</td>
<td>32</td>
</tr>
<tr>
<td>over 10</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Place markers:
- Near valves, flanges and changes in pipe direction.
- At both sides of ceiling, wall or floor penetrations.
- At any line entry point.
- At frequent intervals on straight pipe runs. Every 50 feet is typical.
- Locate pipe markers so they are visible from the point of normal approach.
- Provide arrows at one or both ends of the label to indicate direction of flow.
Expansion, Contraction and Vibration

Piping and equipment shall be installed to allow for freedom of movement during expansion, contraction or vibration. Provide power driven equipment of quiet operation and free of vibration. Design and construct connections to equipment so that noise and vibration will not reach the conditioned areas through doors, conduits, piping, sheet metal and building construction. Power driven equipment shall have quiet operation and have vibration levels at or less than industry standards.
22 10 00 PIPING STANDARDS

Design Standard
In all instances, installation shall conform to manufacturers’ recommendations and industry standards

<table>
<thead>
<tr>
<th>SERVICE</th>
<th>MATERIAL</th>
<th>TYPE</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A. Sanitary Waste</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Up to and including 2&quot; (above grade)</td>
<td>cast iron B &amp; S</td>
<td>service weight B &amp; S - N.H.</td>
</tr>
<tr>
<td></td>
<td>copper</td>
<td>Type M</td>
</tr>
<tr>
<td>See notes 1, 9)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. 3&quot; to 8&quot; (above and below grade)</td>
<td>cast iron soil B-S</td>
<td>service weight B &amp; S - N.H.</td>
</tr>
<tr>
<td></td>
<td>copper</td>
<td>Type M</td>
</tr>
<tr>
<td>3&quot; and larger (above grade)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>cast iron</td>
<td>service weight B &amp; S - N.H.</td>
</tr>
<tr>
<td>3&quot; and larger (above grade)</td>
<td>vitrefied clay pipe</td>
<td>extra strength P.V.C.</td>
</tr>
<tr>
<td></td>
<td>extra strength</td>
<td></td>
</tr>
<tr>
<td></td>
<td>galvanized steel</td>
<td>Schedule 40</td>
</tr>
<tr>
<td></td>
<td>copper</td>
<td>A53 seamless</td>
</tr>
<tr>
<td>2. All sizes over 2&quot;</td>
<td>cast iron B &amp; S</td>
<td>B &amp; S - N.H.</td>
</tr>
<tr>
<td>(below grade)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>&quot;Orion&quot; or equivalent, in standard iron pipe sizes</td>
<td>acid resistant polypropylene</td>
</tr>
<tr>
<td>C. Acid Waste piping</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>copper</td>
<td>Type &quot;L&quot;, hard drawn</td>
</tr>
<tr>
<td>D. Domestic Hot Water</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>copper</td>
<td>Type &quot;K&quot;</td>
</tr>
</tbody>
</table>

REVISED MARCH 2010
### Service Material Type

#### E. Domestic Cold Water
1. All, above grade  
   - Material: copper  
   - Type: Type "L", hard drawn
2. All, below grade  
   - Material: copper  
   - Type: Type "K"
3. Pipe 4" and larger  
   - Material: cast iron  
   - Type: mechanical joint, concrete lined for water service

#### F. Air
1. All  
   - Material: black steel  
   - Type: schedule 40 A53 seamless grade B Black Pipe  
   - Material: copper  
   - Type: Type "L" hard drawn

#### G. Gas
1. Above Grade  
   - Material: black steel  
   - Type: schedule 40 A53 seamless Grade B black pipe
2. Below grade  
   - Material: polyethylene  
   - Type: schedule 40 A53 seamless Grade B Black Pipe

#### H. Vacuum
1. All  
   - Material: P.V.C.  
   - Type: schedule 40 A53 Seamless Grade B Black Pipe  
   - Material: copper  
   - Type: Type "L" hard drawn

#### I. R.O./Distilled Water
1. In tunnels  
   - Material: aluminum #3003, stainless steel #304
2. In buildings  
   - Material: plastic  
   - Type: rigid PVC, schedule 80 with cement fittings

#### J. Panel Heating
1. All  
   - Material: copper  
   - Type: type "L" hard drawn

#### K. Refrigeration
1. All  
   - Material: copper  
   - Type: type "L" hard drawn
22 30 00 PLUMBING SYSTEMS

Backflow Devices

All backflow protection will comply with the local ordinance of the municipality in which the campus is located, (e.g. City of Tempe Ordinance 87.57 Article V for ASU at the Tempe Campus). The DP shall provide detail diagrams of all equipment, connections and regulating devices and all utility connections on prints. All valves shall be installed at any service connections from mains and at such other points to permit isolation of portions of service to minimize other building service interruptions. The Contractor shall furnish a copy of testing (sterilization of systems) and inspection results needed before the building is to be occupied. All domestic water services to buildings shall have two backflow devices in parallel so service will not be interrupted during testing.

SANITARY SEWER-DRAIN & VENTS

A. Provide two-way clean-out on building drains, outside building.

B. Provide clean-outs on waste system on all floors for maintenance.

C. Eliminate urinal trap arms.

D. Traps and waste lines below grade for floor receptors shall be a minimum of 3 inch.

E. Test tees shall be used for testing waste and vent systems. Do not separate piping systems and cap ends for testing.

F. Husky S-D-4000 SS or Mission Heavy Weight couple or equal shall be used on no hub pipe, above and below grade.

G. Clean-outs shall be installed every 50 feet on straight runs.

H. Floor sinks shall be installed in equipment rooms with trap primers.

I. Trap primers are to be exposed and non-mechanical type are to be used.

J. Install floor drains in restrooms, and drying areas.

K. When a sewer line passes through the tunnel at ASU at the Tempe campus, ductile iron pipe shall be used (no joints in tunnel), and sleeve penetration sealed with expansive water tight material.

L. Sewage ejector vent shall be V.T.R. separately.

M. Condensate drains from equipment shall have union connections and clean-outs at change in directions.

N. Type M Copper shall be used on condensate drains.
O. Extend all plumbing vents a minimum 24 inch above finished roof.

DOMESTIC WATER SYSTEMS

A. Asbestos cement pipe and materials shall not be used.

B. Type L or K hand drawn copper shall be used above grade.

C. Type K soft drawn copper shall be used below grade (No joints below grade-concrete).

D. Type M copper shall not be used on water systems.

E. Copper lines 2-1/2 inch and larger shall be brazed or press fit.

F. In lieu of soldering or brazing, mechanical connections using ‘press fit’ type technology may be used.

G. Domestic water systems shall be labeled.

H. P.V.C. pipe is prohibited for the domestic water supply.

I. Branch connections shall be made at the top of the main.

J. All tunnel installations at ASU at the Tempe Campus shall be in accordance with the existing supports and hangers as illustrated.

K. Sleeves shall be installed when core drilling floors (1 1/2 inch minimum above floor).

L. Provide drains at low points (full port valve and plugs; no hose bibs).

M. Lug-type butterfly with stainless steel discs and ball valves shall be installed in the system. No gate valves (domestic water only).

N. Protect un-insulated copper piping by using trisolators or copper coated supports.

O. Wrap piping when passing through sleeves or when having contact with structure supports.

P. A copy of testing results shall be submitted to Planning and Construction.

Q. Executive Order #91-3 Water Conservation for State Facilities shall be followed.

R. Provide loose key hose bibbs in all equipment rooms, public restrooms and roofs, for the purpose of cleaning and maintenance.

S. All water outlets dispensing "non-potable" water will have signage posted giving warning - "Water not for consumption."
PLUMBING EQUIPMENT

A. All equipment shall be installed with union or flanged connections.

B. Sewage ejector sewer pumps shall have union or flanged gate valves, check valves and cast iron sumps.

C. Sewage ejector and sump pumps shall be wired to the emergency power system (include condensate pumps).

D. High water alarm shall be connected to Central EMCS System on all sewage ejector systems.

E. Gate valves shall have a rising stem with packing nut. 3 inch and larger shall be O.S.Y. - flanged.

F. Self-closing valve or faucets shall be installed on distilled water systems.

G. Flanged or union type expansion joints shall be installed (Steam-condensate and water systems).

H. Thermometer indicators shall be installed on all heat transfer equipment and systems.

I. Pressure gauges shall be installed wherever needed; before and after regulators and filter devices, pump supply, and discharge.

J. Stainers shall be placed ahead of all regulators, pumps control equipment, or any equipment that could be damaged or rendered inoperative due to foreign matter in the piping.

K. Shock absorbers shall be installed where there are two or more quick closing valves installed.

L. Trap primer shall be installed where necessary (E.Q. rooms; isolated areas).

WATERLESS URINALS

Arizona Revised Statute 45-313.01 requires that, whenever feasible, waterless urinals be installed in all new state buildings. In addition to new buildings, ASU will install as many water free urinals in as many ASU buildings as possible, if ASU determines that, given all of the circumstances, their use is in the best interest of ASU.

CIVIL REQUIREMENTS

A. Asbestos cement pipe and material shall not be installed.

B. Sewer lines shall be installed with clean-outs at every 50 feet.
C. Provide detail diagrams on prints for sewer, manhole and water connections.

D. Support backflow devices as required by manufacturer.

E. Testing shall be required on building sewer, storm drains and water mains.

F. Sterilization of water mains shall be required.

G. Sub-contractors excavating on campus shall notify Capital Programs Management Group before work begins.

H. Any and all piping exposed during excavation shall be brought to the attention of the respective Capital Programs Management Group before backfilling is complete.

PLUMBING FIXTURES, ELECTRIC DRINKING FOUNTAINS

Description

This section applies to all public/private accessible electric drinking fountains. There will be a minimum (unless otherwise stated by code) at least two (2) electric drinking fountains per floor of a building. Each fountain shall be fully accessible to the disabled, and comply with the below cited criteria.

Design Standards

- Preferred manufacturer is Elkay;
- Remote chiller units are discouraged;
- Surface or recess mounted;
- Unit shall have a stainless steel receptor with painted cabinet;
- Push-bar operation;
- Life-time lubricated hermetic compressor with 1/5 HP, 120V, single phase motor;
- Minimum capacity of 7.5 gph, 50° F inlet, 90° F ambient air.
- Mount at ADA level.

EMERGENCY EYEWASHES / EMERGENCY SHOWERS

A. Plumbed and Self Contained Emergency eyewashes and showers many only be installed if they meet the requirements of the current ANSI Z358.1 standard.

B. Contractors and ASU employees installing new equipment do not have to meet the requirement of tepid water.

C. Personal wash units (squeeze bottles, drench hoses) are only to be used to supply immediate flushing. These units should not replace or be installed in place of
D. A drench hose may be considered an eyewash/face wash if the device meets the performance requirements of the current Z358.1 standard pertaining to Plumbed and Self Contained Emergency Eyewashes and Showers. Drench hoses should only be used as a support for plumbed emergency eyewashes and showers.

E. Contractors and ASU employees installing new Plumbed and Self-Contained Emergency Showers and Emergency Eyewashes should also review the appendices in the back of the current ANSI Z358.1 standard.
DIVISION 23 - HEATING, VENTILATING, AND AIR CONDITIONING

23 05 00 GENERAL PROVISIONS

The work of Division 23, Heating, Ventilating and Air Conditioning, is subject to the conditions of the contract and Division 01.

Description

The utility services for the ASU at Tempe campus are from a Central Utility Distribution System, which includes chilled water, steam, domestic hot water, distilled water, primary electrical power, and emergency power systems via a tunnel system. Contact Capital Programs Management Group regarding utility services at the various campuses.

All new buildings and building expansion projects shall utilize central utility services, if applicable. It is imperative that building utility requirements be calculated at the programming or schematic design submittals to assure adequate services are available at anticipated connection points. Refinement is expected as design progresses and shall be finalized at the design development stage, with final interconnection requirements identified.

In general, the type of system should be variable air volume with provision for a maximum of 100% makeup or outside air and utilize an economizer cycle in the control scheme. It is preferred that each floor have its own HVAC system so that a system problem does not affect the entire building. Requirements of the systems vary, as in the case of laboratory buildings or similar structures, where large quantities of contaminated air or air change requirements have to be exhausted. At the completion of the design development phase, the DP shall present to ASU for approval, a comprehensive layout of the heating and air conditioning systems, describing the functions, method of temperature control, location of equipment, ducts, piping, etc.

Design Standard

A. The central chilled water distribution system is designed and operated to deliver 42°F chilled water from the central plant, no greater than 44°F chilled to all points on campus. From any new building or building expansion, the return chilled water leaving the building shall be no less than 56°F at any time.

B. Each building shall have a building chilled water pump to handle the building chilled water distribution requirement. It is the intent to apply variable pumping technology to all buildings and to be controlled by the building control system. The design of the building chilled water system shall not allow any pressure carryover to the chilled water distribution system. The building chilled water system shall be "de-coupled" from the central chilled water distribution system, and shall be provided with a cyclone type seaparator upstream of the building pumps.

C. The chilled water supply to each building will have an automated isolation valve to prevent chilled water flow whenever the system is not in use. A variable frequency driven pump will provide the necessary head pressure to match the load in the building, and two-way motor driven control valves will modulate the flow to the building pumps. Use of the minimum flow and head pressure needed will also
mitigate the impact on the plant distribution system.

D. Central chilled water distribution system pressure operates between 35-85 PSIG; the return system pressure is 5-10 PSI lower at system end points. The distribution pumping operates to maintain this differential depending on loads and grid location.

E. The central steam distribution system delivers 70-85 PSIG saturated steam throughout campus. All condensate shall be returned via the pumped condensate return system. Building heating systems shall be hot water produced by a steam-to-hot water converter.

F. Chilled water will be supplied at no greater than 44 degree Fahrenheit, at the rate of 1.7 gallons per ton.

G. The building chilled water pump(s) and hot water (heating) pump will be rated for the building requirement. Chilled water flow (pumping) should be load responsive rather than constant where possible.

H. All utility services shall be metered.

I. For new or tie-in to existing tunnel utility source at the ASU at Tempe campus, contact Capital Programs Management Group. All new tunnels shall be as wide as possible with a minimum walking clearance of 3'-0". All connections to existing systems shall not obstruct walking clearances. All tie-ins shall have a valve at the connection point accessible for operation.

J. All new steam condensate, condenser, heating hot water, closed loops, and chilled water system piping shall be chemically cleaned and pretreated in accordance with the parameters designated by the chemical company under contract to ASU (currently Nalco).

K. All tie-ins to utilities shall be coordinated through Capital Programs Management Group.

L. Equipment requiring OEM parts is not desirable.

CODES

A. Include without additional cost to owner all labor, services, apparatus and drawings required to comply with applicable laws, ordinances, rules and regulations.

B. Applicable mechanical, electrical, gas, plumbing, health/safety and sanitary codes, laws and ordinances:

- National Electrical Manufacturer’s Association Standards
- National Electrical Code
- Underwriter’s Laboratories, Inc. Standards
- American Society for Testing Materials Standards
- Uniform Mechanical Code
- Uniform Plumbing Code
Products

Materials and equipment shall be standard products of a reputable manufacturer regularly engaged in manufacture of the specified items. Where more than one unit is required of any item, furnish by the same manufacturer except where specified otherwise. Install material and equipment in accordance with manufacturer's recommendations.

Valves (Heating / Cooling)

On mechanical systems, no sweat connection valves shall be used. Use only flanged or threaded valves.

Include sufficient zone isolation/shut off valves in cold/hot water, heating hot water, chilled water, steam and other service piping to allow maintenance and replacement of terminal equipment without shutting down entire building. This does not apply to refrigeration piping.

Install valves on lines that penetrate the floor from below. Install valves on all branch lines off of the main lines. Install valves on all lines at locations such that each floor can be isolated independent of main building.

Mechanical Rooms and Equipment Locations

Provide adequate safe access and manufacturer’s recommended working clearances for all equipment. Provide for replacement of the largest pieces of equipment without removing permanent walls, large items of equipment or equipment essential to the principal on-going day to day building use. Provide direct access from the exterior for major mechanical rooms exceeding 100 net square feet.

In phased projects, mechanical rooms shall be sized to include equipment for all the phases. Mechanical rooms shall have a floor drain.

Existing Installations and Conflicts

Protect existing active services (water, gas, sewer, electric, etc.), when encountered, against damage from construction work.

Nameplates and Coding

Identify all items of mechanical equipment by approved nameplates. Approved nameplates shall be engraved laminated plastic with white lettering and black background. Lettering/numbering will be no less than 3/4" in height. Nameplates exposed to sunlight will be made of UV resistant material. Secure nameplates to each individual piece of equipment.

The identification shall correspond to the designation used on the construction drawings, and shall include, but not be limited to, the following:
1. Air handlers  
2. Fans  
3. Pumps  
4. Air Compressors  
5. Refrigeration equipment  
6. Boilers  
7. Heat exchangers  
8. Tanks  
9. Receivers

Identify piping according to ANSI A13.1.

**Expansion, Contraction and Vibration**

Piping and equipment shall be installed to allow for freedom of movement during expansion, contraction or vibration. Provide power driven equipment of quiet operation and free of vibration. Design and construct connections to equipment so that noise and vibration will not reach the conditioned areas through doors, conduits, piping, sheet metal and building construction. Power driven equipment shall have quiet operation and have vibration levels at or less than industry standards.

**POSSIBLE CONCEPTS TO UTILIZE**

**Design Standard**

A. Chilled water and steam (to HW converter and Domestic Hot Water) services from the Central Plant distribution system.

B. Supplemental indirect evaporative cooling systems to reduce chilled water requirements for large air change facilities.

C. Variable air volume system with zone reheat coils, economizer cycles, variable frequency drives on supply and return air fans.

D. Zoned for control of interior spaces (cooling only), and east and west exposures for energy efficient operation;

1. Water flow control based on return temperatures (flow to match building loads - vary primary flow for distribution system to maintain a minimum temperature differential of 14° F between supply and return to central tunnel distribution system at ASU at the Tempe campus);

2. Adequate zone sensors for control. Discharge air temperature of primary air handling unit to be based on high/low zone selection. High occupancy designed spaces shall use CO² sensing to control outside air make-up;

3. Closed loop DDC control; local processing unit and data transmission to host computer (Honeywell Excel Plus) located in the Central Plant;
4. Air pressure balance of building to ambient;
5. Minimum stop on V.A.V. boxes of no less than 20%; vary supply air temperature to match low zone requirements; and
6. Sufficient redundancy of fans or ducting to handle 2/3 of building peak load requirements with one unit out of service (parallel S&R fans at 2/3 design air flow requirements), or one system per floor.

E. If VAV is not economically possible, systems to consider in order are:

1. Single zone systems (zoned per floor or interior/exterior) in heating or cooling modes (no overlap); and
2. Multizone systems with a non-conditioned bypass (3-deck multizone).

F. Mainframe computer centers and server rooms shall have a separate system so the balance of building can be controlled separate from the computer room needs. Chilled water shall be provided by means of a separate set of pumps directly connected to the campus main chilled water system.

G. In general, set points to be seasonal as follows:

<table>
<thead>
<tr>
<th>Control</th>
<th>Design</th>
</tr>
</thead>
<tbody>
<tr>
<td>Winter</td>
<td>75° F</td>
</tr>
<tr>
<td>Summer</td>
<td>72° F</td>
</tr>
</tbody>
</table>

H. In determining heating and conditioned air requirements for any given space, consideration shall be given to each and all of the following factors which may be pertinent and the largest of resulting quantities shall be used;

1. Air required on a per capita basis, i.e., CFM per person times number of persons; or CO² sensing where possible.
2. Air required on basis of type of occupancy, equipment heat gains (or loss), or architectural heat gains;
3. Air required for fume hoods, kitchen hoods, or other special exhaust equipment; minimum air required by code;
4. Air required for combustion in fuel burning equipment;
5. Minimum ventilation air required per capita shall be based on the latest ASHRAE standards (90-1; dated 1989) as shown in Division 0, section 00200.

I. In general, the ventilation rates should be based on the number of people in the space. If ventilation rates are required for other reasons, consult the ASHRAE Standard for Recommended Ventilation Rates.

J. In general, meet or exceed ASU requirements for Energy conservation and comfort
setting guidelines as directed by Capital Programs Management Group
23 05 93  AIR & WATER BALANCE

Description

The services of an independent agency, on a separate contract, for balancing the air and water systems shall be developed. In most cases, ASU will separately contract for those services to assure quality testing; therefore, the designer shall develop a separate bid package for these services. This does not remove this requirement from the contractors scope of work; it is to verify the balance was performed according to the contract documents.

ASU's operating personnel shall be given instructions and training during the first year warranty periods.

BALANCING SPECIFICATIONS

Scope

In accordance with Project Drawings and Specifications and as specified herein, the balancing agency shall provide all supervision, personnel, instruments, calibration equipment, and all other materials and services necessary to perform all testing and balancing of the heating, ventilating and air conditioning systems. All test data including all pertinent calculations shall be reported on appropriate forms.

General

A. The testing and balancing of the heating, ventilating and air conditioning systems shall be performed by an independent balancing agency approved by the Owner. The balancing agency shall have a minimum of five years specialized experience in air and hydronic system balancing, and possess calibrated instruments, qualified test and balance engineers, and skilled technicians to perform all required tests. The balancing agency shall be a certified member of the AABC or NEBB.

B. The tests shall demonstrate the specified capacities and operation of all equipment and materials comprising the systems. The balancing agency shall then make available to the Owner's representative such instruments and technicians as are required for spot checks of the system.

C. The balancing agency shall not instruct or direct the mechanical contractor in any of the work. Any proposed changes or revision in the work shall be submitted to the DP in writing. The DP shall, in coordination with his engineer, process the proposal as appropriate.

Services

A. During construction, the balancing agency shall inspect the installation of pipe systems, sheet metal work, temperature controls and other component parts of the heating, ventilating and air conditioning systems. The inspections shall be performed periodically as the work progresses. A minimum of two inspections are required as follows:
1. when 60 percent of the duct work is installed;
2. when 90 percent of the equipment is installed.

The balancing agency shall submit a brief written report of each inspection to the Owner.

B. Upon completion of the installation and start-up of the mechanical equipment by the mechanical contractor, the balancing agency shall test and balance the system components to obtain optimum conditions in each conditioned space in the building. If construction deficiencies are encountered that preclude obtaining optimum conditions, and the deficiencies cannot be corrected by the mechanical contractor within a reasonable period of time, the balancing agency shall cease testing and balancing services and advise the Owner in writing of the deficiencies.

**AIR SYSTEM PROCEDURES**

A. The balancing agency shall perform the following testing and balancing functions in accordance with the Associated Air Balance Council's *National Standards*:

1. Fan Speeds - test and adjust fan RPM to achieve design CFM requirements.
2. Current and Voltage - measure and record motor current and voltage.
3. Pitot-tube Traverse - perform a Pitot-tube traverse of main supply and return ducts to obtain total CFM. If a Pitot-tube traverse is not practical, the summation of the outlets or inlets may be used. An explanation why a traverse was not made must appear on the appropriate data sheet.
4. Outside Air - test and adjust system minimum outside air by Pitot-tube traverse. If a Pitot-tube traverse is not practical, the percentage of outside air may be determined by calculations from the return air, outside air, and mixed air temperatures. Make allowances for heat of compression and motor heat where applicable.
5. Static Pressure - test and record system static pressures, including suction and discharge static pressure of each fan.
6. Air Temperature - take wet-bulb and dry-bulb air temperatures on the entering and leaving side of each cooling coil. Dry-bulb temperature shall be taken on the entering and leaving side of each heating coil.
7. Zone Ducts - adjust zone ducts to within design CFM requirements. At least one zone balancing damper shall be completely open.
8. Main Ducts - adjust main ducts to within design CFM requirements and traverse for total CFM requirements.
9. Branch Ducts - adjust branch ducts to within design CFM requirements. Multi-diffuser branch ducts shall have at least one outlet or inlet volume damper completely open.

10. Tolerances - test and balance each diffuser, grille and register to within 10 percent of design requirements.

11. Identification - identify the location and area of each grille, diffuser, register, and terminal box. This information shall be recorded on air outlet data sheets.

12. Description - record the size, type and manufacturer of each diffuser, grille and register on air outlet data sheets.

13. Terminal Boxes - set volume regulators on all terminal boxes to meet design maximum and minimum CFM requirements. All associated temperature controls shall be checked for proper operation and calibration. If the terminal boxes have separate settings for heating and cooling CFM, the CFM quantities for each shall be recorded on air outlet data sheets. All diffusers connected to the terminal box shall be read in the heating and cooling modes and their readings recorded on air outlet data sheets.

14. Minimizing Drafts - adjust all diffusers, grilles and registers to minimize drafts in all areas.

CHILLED WATER AND HOT WATER PROCEDURES

A. The various water circulating systems shall be flushed with clean water, filled, pump strainers removed, cleaned and replaced, pressure tested, water treated, purged of air, and put into operation before hydronic balancing by the mechanical contractor.

B. The flow of water through all coils shall be adjusted by manipulating balancing valves until the rated pressure drop through the coil or metering device is obtained. On variable flow systems, flow rates shall be set for maximum conditions.

C. The balancing agency shall perform the following testing and balancing functions in accordance with the AABC National Standard.

1. Water Treatment - examine the water in the system and determine if the water has been treated and cleaned.

2. Strainers - request that the mechanical contractor clean all strainers.

3. Air Vents - check all air vents at the high points of the water system and determine if they are installed and operating with ball valve for isolation.

4. Valves - set all balancing valves and automatic temperature control bypass valves to the full-open position for balancing. For three-way valves, the rated pressure drop shall first be adjusted with the three-way valve set so that all water flows through the coil until equal pressure drop between supply and return connections is obtained, with the three-way valve set to bypass the coil.
5. Pumps - adjust chilled water, hot water and condenser water pump to meet design GPM requirements. Check pumps for proper operation. Pumps shall be free of vibration and cavitation. Measure and record operating current and voltage.

6. Central Plant - adjust water flow from the central plant if applicable.

7. Tolerances - proceed to balance all chilled water and hot water coils within 10 percent of design requirements.

8. Marking - mark all settings and record all data after completing the flow readings and coil adjustments.

9. Thermal Performance - if the cooling tower performance has not been certified by the Cooling Tower Institute (CTI) in accordance with CTI Certification Standard STD-201, a field acceptance test shall be conducted within the warranty period in accordance with CTI Acceptance Test Code ATC-105 by a certified agency of the Associated Air Balance Council.

SOUND DATA RECORDING

SPECIAL SYSTEMS PROCEDURES

As required, special systems procedures must be specified separately.

VERIFICATION OF TEMPERATURE CONTROL

A. The balancing agency shall be assisted by the temperature control contractor in verifying the operation and calibration of all temperature control systems. The following tests shall be conducted:

1. Verify that all control components are installed in accordance with project requirements and are functional, including all electrical interlocks, damper sequences, air and water reset, and fire and freeze stats.

2. Verify that all controlling instruments are calibrated and set for design operating conditions.

3. Verify the accuracy of the final settings by taking temperature readings. The readings shall be in a typical conditioned space for each separately controlled zone.

TEST AND BALANCE REPORT

A. The test and balance report shall be complete with logs, data and records as required herein. All logs, data and records shall be typed on white bond paper and bound. The report shall be certified accurate and complete by the balancing agency's certified test and balance engineer.

B. Five (5) copies of the test and balance report are required and shall be submitted to the Owner.
C. The report shall contain the following general data in a format selected by the balancing agency:

1. Project number
2. Contract number
3. Project title
4. Project location
5. Project architect
6. Project mechanical engineer
7. Test and balance agency
8. Test and balance engineer
9. General contractor
10. Mechanical subcontractor
11. Dates test were performed.
12. Certification

D. The test and balance report shall be recorded on report forms conforming to the recommended forms in the AABC National Standards. At a minimum, the report shall include:

1. Preface. A general discussion of the system, any abnormalities and problems encountered.

2. Instrumentation list. The list of instruments including type, model, manufacturer, serial number, and calibration dates.

3. In each report, the VAV boxes, zones, supply, return and exhaust openings, and traverse points shall be numbered and/or lettered to correspond to the numbers and letters used on the report data sheets.

4. Air handling equipment test report forms. Record the following on each air-handling equipment test form:
   a. Manufacturer, model number and serial number
   b. All design and manufacturer rated data
   c. Total actual CFM by traverse if practical. If not practical, the sum of the outlets may be used, or a combination of each of these procedures. For specific systems, such as ones with diversity, see the AABC National Standards.
   d. Suction and discharge static pressure of each fan, as applicable.
   e. Outside air and return air total CFM.
   f. Actual operating current, voltage, and brake horsepower of each fan motor.
   g. Final RPM of each fan.
   h. Fan and motor sheave manufacturer, model, size, number of grooves, and center distance.
   i. Belt size and quantity.
   j. Static pressure controls final operating set points.

5. Pump test forms. Submit pump curve showing design, operating and no-flow points of operation. Also, record the following items on each pump test form:
   a. Manufacturer, size, and serial number
b. All design and manufacturer related data
c. Pump operating suction and discharge pressure and final total dynamic head
d. No flow (pump discharge valve closed), suction and discharge pressure and corresponding total dynamic head. This procedure is to determine actual impeller size.
e. Related and actual operating current, voltage, and brake horsepower of each pump motor.

6. Chiller test forms. Record the following items for each chiller.

a. Manufacturer, size, and serial number
b. All design and manufacturer related data
c. Rated and actual pressure drop across evaporators and condensers and related GPM.
d. Entering and leaving water temperatures
e. Rated and actual operating current and voltage.

7. Heat exchanger test forms. Record the following items on each heat exchanger test form:

a. Manufacturer, size, and serial number
b. All design and manufacturer related data
c. Service and location
d. Actual pressure drop and related GPM or steam pressure, primary side
e. Actual pressure drop and related GPM, secondary side
f. Primary side entering and leaving temperatures
g. Secondary side entering and leaving temperatures
h. Temperature control setting

8. Heating and cooling-coil test forms

Record the following items on each test form:

a. Manufacturer
b. All design and manufacturers' rated data
c. Rated and actual water pressure drop through each coil and related gPM
d. Rated and actual static pressure drop across each coil
e. Entering and leaving water temperatures
f. Wet-bulb and dry-bulb temperatures entering and leaving each cooling coil; dry-bulb temperatures entering and leaving each heating coil

9. Electric heating coil/duct heater test forms

Test and record the following on each electric heating coil test form:

a. Manufacturer and model number
b. All design and manufacturer related data
c. Actual operating current and voltage
d. Coil location and identification number
10. Cooling tower test forms (if applicable)

Include the following:

a. A copy of the Cooling Tower Test Data Summary Sheet
b. A sketch of the cooling tower installation showing tower orientation, principal dimensions, location of temperature and flow-rate measurement points, and notation of any buildings, obstructions, or other equipment in the immediate vicinity of the tower.
c. Copies of completed test data sheets.
d. A copy of test calculations, including performance curves and cross-plots.
e. Observations on compliance with Test Code limitations and uniformity of test conditions. Include comments on any suggested changes to the tower such as increasing fan speed or blade pitch to obtain rated brake horsepower.

FINAL ACCEPTANCE

A. At the time of final inspection, the balancing agency shall recheck, in the presence of the owner's representative, specific and random selections of data recorded in the certified test and balance report.

B. Points and areas for recheck shall be selected by the owner's representative.

C. Measurements and test procedures shall be the same as the original test and balance.

D. Selections for recheck, specific plus random, shall not normally exceed 15 percent of the total number of tabulated in the report, except where special air systems require a complete recheck for safety reasons.

E. If random tests demonstrate a measured flow deviation of 10 percent or more from that recorded in the certified test and balance report, the report shall automatically be rejected. In the event the report is rejected, all systems shall be readjusted and tested, new data recorded, a new certified test and balance report submitted, and a new inspection test made, all at no additional cost to the owner.

OPPOSITE SEASON TEST

A. The balancing agency shall perform an inspection of the HVAC system during the opposite season from that in which the initial adjustments were made. The balancing agency shall make any necessary modifications to the initial adjustments to produce optimum system operation.

The balance agency shall also conduct tests in selected areas of the building for sound levels:

1. Sound level readings shall be measured in decibels on the "A" scale of the General Radio Company Sound Level Meter, or equal sound level meter;
2. Readings shall set forth the total random sound level of the selected rooms or areas with the system in operation, as compared to total background sound level with the system not in operation;

3. The system increase over the background level shall be recorded in decibels on the "A" scale;

4. Sound level readings (in decibels) shall be taken for all rooms;

5. Sound level readings shall be taken in each HVAC equipment room and a minimum of 10 places as selected by the DP;

6. Where measured sound levels exceed acceptable level, contractor and/or equipment manufacturer shall take remedial action and repeat tests;

7. If air flows are changed, a balance will be required at no additional cost to ASU;

8. Sound reference level, noise criteria, formulae and coefficients shall be according to ASHRAE Guide, chapter Sound Control.

R. All tests and balance reports and other requirements of this section shall be completed and furnished to DP prior to Final Inspection.

S. A complete copy of all test and balance reports shall be included in each copy of the Maintenance Manual

23 06 30 HVAC CFM / TEMPERATURE GUIDELINES

Description

This section includes general temperature and cfm requirements only. The DP shall review with the Department of Planning and Construction specific room requirements no later than 50% schematic design phase.

The minimum ventilation air required per capita or person should be based on the latest ASHRAE Guidelines such as shown in the following tabulation:

<table>
<thead>
<tr>
<th></th>
<th>Persons per 1000 sq. ft. floor area</th>
<th>Required cfm per Occupant</th>
<th>Vent Air Minimum Recommended</th>
</tr>
</thead>
<tbody>
<tr>
<td>Classrooms</td>
<td>50</td>
<td>15</td>
<td>15-20</td>
</tr>
<tr>
<td>Multiple-Use Rooms</td>
<td>70</td>
<td>15</td>
<td>15-20</td>
</tr>
<tr>
<td>Laboratories (a)</td>
<td>30</td>
<td>20</td>
<td>20-25</td>
</tr>
<tr>
<td>Craft Shops, Vocational Training Shops (a)</td>
<td>30</td>
<td>20</td>
<td>20-25</td>
</tr>
<tr>
<td>Music, Rehearsal Rooms</td>
<td>50</td>
<td>15</td>
<td>15-20</td>
</tr>
<tr>
<td>Gymnasiums</td>
<td>70</td>
<td>20</td>
<td>25-30</td>
</tr>
<tr>
<td>Libraries</td>
<td>20</td>
<td>15</td>
<td>15-20</td>
</tr>
</tbody>
</table>

II - 116
REVISED MARCH 2010
<p>| | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Common Rooms, Lounges</td>
<td>70</td>
<td>15</td>
<td>15-20</td>
</tr>
<tr>
<td>Offices</td>
<td>10</td>
<td>15</td>
<td>15-20</td>
</tr>
<tr>
<td>Lavatories</td>
<td>100</td>
<td>15</td>
<td>20-25</td>
</tr>
<tr>
<td>Locker Rooms (b)</td>
<td>20</td>
<td>30</td>
<td>40-50</td>
</tr>
<tr>
<td>Lunchrooms, Dining Halls</td>
<td>100</td>
<td>15</td>
<td>15-20</td>
</tr>
<tr>
<td>Corridors</td>
<td>50</td>
<td>15</td>
<td>20-25</td>
</tr>
<tr>
<td>Utility Rooms</td>
<td>3</td>
<td>5</td>
<td>7-10</td>
</tr>
<tr>
<td>Dormitory Bedrooms</td>
<td>20</td>
<td>10</td>
<td>10-15</td>
</tr>
</tbody>
</table>

(a) Special contaminant control systems may be required.
(b) Cfm/locker.

Unless specific process equipment requirements dictate a deviation, the temperature for air spaces at ASU will be as follows:

<table>
<thead>
<tr>
<th></th>
<th>CONTROL</th>
<th>DESIGN</th>
</tr>
</thead>
<tbody>
<tr>
<td>Winter</td>
<td>75° F</td>
<td>75° F</td>
</tr>
<tr>
<td>Summer</td>
<td>75° F</td>
<td>72° F</td>
</tr>
</tbody>
</table>

**23 07 00 INSULATION SCHEDULE FOR HEATING & A/C SYSTEMS**

**PIPING**

**Design Standard**

A. Piping insulation shall be installed according to industry standards and technology.

B. All exposed insulation at floor level and up to 6’ above floor level will be finished with 8 oz. canvas covering, sized with a white lagging adhesive.

C. A solid insulation insert shall be installed between all pipe and hangers, rollers and other support points. This insulation shall be the same thickness as the adjoining insulation and wide enough to prevent crushing under the weight of the filled pipe.

D. All insulated pipes shall have a protective metal shield inserted centrally at all hangers, rollers, and support points.

1. Shields shall be of galvanized steel and shall cover the lower 1/2 of the insulation.

2. Shields for pipe up to 6 inch in diameter shall be 18 gauge, 12 inch long.

3. Shields for pipe above 6 inch shall be 16 gauge, 18 inch long.

4. Size and thickness of shields should not be left to discretion of installing contractor.

5. Similar shields shall be installed on sides and tops of all insulated piping at
locations where such piping is in the path of normal personnel traffic, and the insulation would be subject to damage from such traffic.

E. Where water damage may occur, condensate drains will be insulated for a minimum of 6’ from the condensate pan.

**DUCT INSULATION**

**Design Standard**

A. Duct insulation shall be installed according to industry standards and technology.

B. All exposed insulation at floor level and up to 6’ above floor level will be finished with 8 oz. canvas covering, sized with a white lagging adhesive.

C. Duct wrap or fiberglass board to insulate the outside of the duct. Duct liner will not be used.

**23 21 23   PUMPS**

**Description**

These standards apply to the selection and installation of pumps for hot and cold water circulation, sewerage, sump and steam condensate return systems. Not included are vacuum pumps, heat pumps, sewage lift stations, ejectors, air pumps, or piston pumps.

**General**

A. Pump selection shall be based on highest efficiencies of non-proprietary products available.

B. Piping system design shall be based on insuring lowered Bhp per unit flow rate at maximum flow and head.

C. Pumps shall be located where easily accessible for service, yet isolated to prevent pumping or vibration source noise from disturbing the occupied area.

D. Pumps shall not operate at more than 1800 rpm (whenever possible). Pumps shall have premium efficiency motors that are VFD compatible.

E. Centrifugal type pumps should be selected so that shut-off head is not more than 25% greater than operating head.

F. Pump head shall be calculated and included in system design computations.

G. Where the pump inlet is above water supply level, both suction and total head shall be included in design computations.

H. Motors for pumps shall be sized (nonoverloading) so they will not be overloaded at any point on the operating curve.
I. If possible, select pumps so that impeller trim may be larger to provide flexibility for future requirements.

PRODUCTS, MATERIALS AND EQUIPMENT

General

A. The pump shall be a complete, integrated unit consisting of pump motor, shaft, frame, and base; as manufactured at the factory.

B. Sump and sewage pumps shall preferably be submersible types, but vertical column type may be used. Solid handling only. No grinder pumps. No self primers.

C. Sump, sewage and steam condensate, chilled water and hot water pumps shall be in duplex arrangement.

D. Steam pressure pumps shall be cast iron and guaranteed for 210° F without flashing.

E. Mechanical seals shall be provided on all pumps. No packing type.

F. Mechanical seals for hot water heating pumps shall be certified by the pump manufacturer to be suitable for the maximum expected water temperature and chemical treatment used.

G. Hot water pumps not designed for exposure to water containing ferrous oxides must be equipped with bypass connections to keep seals flushed.

H. Chilled water pumps shall be frame-mounted, so that the entire casing and connections may be completely insulated.

I. Large pumps should have an air cock in the casing.

J. Pump casings should have tappings for gauges which shall be equipped with pipe extensions and shut-off valves for gauge installations.

K. When only one pump is used, it shall be long coupled. When two pumps in parallel, they shall be close coupled.

L. Pump mounting shall incorporate bolts that can be completely removed, to allow pump and or motor to slide off of its base. No studs for mounting shall be used. Pumps and motor shall be free of any soft foot condition.

M. Co-axial shaft alignment in the offset direction shall be no greater than 4.00 mils total indicator reading. Angular misalignment shall be no greater than 1.0 mils/per inch.

N. House vacuum systems for labs shall be oil cooled duplex or triplex systems. Air cooled, water cooled, or air over heat exchangers shall not be used. Water cooled
heat exchangers may be used where appropriate.

O. All air compressors over 5 HP shall be rotary screw. Sound level shall be 75 DBA or less, and designed to 115 degrees F ambient. Air compressors below 5 HP shall be recip. 1 or 2 stage cast iron.

P. All submersible pump systems shall use ball check valves. No flapper or disc type unless they are sewage rated.

EXECUTION

A. Locate pumps in basement mechanical spaces whenever possible.

B. Floor mounted pumps shall be on concrete bases, 4 inches minimum height, and grouted to the base. No U-channel shall be used for pump or motor mounting.

C. Provide guards over shafts and couplings in accordance with OSHA requirements

D. Pumps shall be accessible for service and maintenance, with a minimum of 24 inches on two adjacent sides.

E. Provide balance valve in the pump discharge piping so the design flow rate may be set.

F. Provide check valves in the pump discharge piping when pumps are operating in parallel, standby, or whenever a reverse flow may occur.

G. Controls for sump and condensate pumps shall provide for "lead-lag" start and shall automatically alternate the pumps depending which is the "lead" start.

H. Provide all pumps except sewage, sump and condensate with inlet strainers as part of the piping or pump inlet accessories.

I. Pumps shall have isolating valves on pump suction and discharge.

23 22 00 STEAM AND CONDENSATE

SYSTEM DESCRIPTION

A. Steam Distribution System: Steam is the primary heat source for a variety of heating functions throughout ASU at Tempe campus. Saturated steam is generated at the Central Plant Facility and distributed via a loop piping system, which operates at 85 psig (327º F). (Design conditions for piping are 135 psig and 400º F. The distribution system serves almost all sections of the ASU at Tempe campus within the boundaries of Mill and Rural and most of everything north of Apache to Rio Salado Drive.

B. Condensate Return System: The condensate return system operates with 180º F condensate at 20 psig. Design conditions for piping are 100 psig and 225º F.
CODE COMPLIANCE AND STANDARDS: Use current edition in effect at time of design and construction.

A. American Society of Mechanical Engineers (ASME) - Boiler and Pressure Vessel Code.

B. American National Standards Institute (ANSI)- B31.1 Power Piping

C. Expansion Joint Manufacturers Association (EJMA) - Standards

QUALITY ASSURANCE

A. All materials shall be certified new from factory. Pipe, fittings, and valves shall be made in the USA or Canada to ANSI/ASME standards and suitably stamped. Piping components made in other countries shall not be used unless specifically approved.

B. Welder Qualifications: Welder(s) shall be qualified in accordance with ASME Section VIII, Pressure Vessels; ASME Section IX, Welding and Brazing Qualifications. Welders shall be thoroughly familiar with ANSI B31.1 requirements.

PIPE AND FITTINGS

A. Pipe:
   1. Steam lines: ASTM A-106 (seamless), Grade B, black carbon steel
      a. 2 inches and smaller: Schedule 80,
      b. 2.5 inch through 10 inch: Schedule 40,
   2. Condensate lines: ASTM A-53 (seamless) Grade B
      a. All sizes to be Schedule 80.

B. Fittings:
   1. Threaded (2 inches and smaller): ASME B16.3 300# class (extra heavy) Malleable Iron,
   2. Butt-Welded (2.5 inch and larger): ANSI B16.9, ASTM A234 WPB, schedule to match pipe.
   3. Flanged (2.5 inch and larger): ANSI B16.5, forged steel, 150-pound class, weld-neck flanges shall be used to match equipment.

VALVES

A. General:
   1. Valves shall be threaded for 2 inch and smaller piping, flanged for 2.5 inch and larger. Socket weld or butt weld valves shall not be used. Acceptable valve
manufacturers for steam or condensate service are provided below; no substitutions unless approved.

B. Gate Valves:
   2. Flanged (2.5 inch and larger): ANSI B16.34, 150 pound class, A216 WCB cast steel body, bolted bonnet, OS&Y., stainless steel trim: Bonney Forge, Velan, Powell, Crane or Milwaukee.
   3. By-pass lines: All gate valves 4 inches and larger shall have bypass lines and drains with appropriately sized valves.

C. Globe Valves: (Regulator By-pass)
   1. Threaded (2 inch and smaller): ANSI B16.34, 800 pound class, forged steel body, stainless steel seat ring and plug, bolted bonnet, rising steam; Bonney Forge, Vogt, GWC, Edwards or Smith.
   2. Flanged (2.5 inch and larger): ANSI B16.34, 150 pound class, A216 WCB cast steel body, OS&Y; stainless steel trim, Bonney Forge, Velan, Powell, Crane or Milwaukee.

D. Ball Valves: (condensate systems only)
   2. Flanged (2 ½” and larger) ASME/ANSI B16.5, B16.10, B16.34, API-607 150 pound class, full port. GWC A150, American 4000D or equal.

E. Check Valves (condensate systems only):
   1. Threaded (for steam trap discharge): (2 inch and smaller) Durabla or DFT (SCV) Stainless Steel spring check.
   2. Flanged (2.5 inch and larger): ANSI B16.34, 150 pound class, A216 WCB cast steel body, bolted flange cover, swing check; Bonney Forge, Walworth or Stockham.
   3. Vertical lift check valves: threaded, 150/200 pound class, bronze body, for steam powered condensate pump, Durabla or DFT SS Silent Check.

PIPPING SPECIALTIES

A. Gaskets: Non-asbestos containing ring gaskets, Spiral wound– 304 flexible graphite or equal, suitable for the fluids and temperatures encountered.

B. Bolting:
1. ASTM A193, Grade B7, for bolts and studs, and ASTM A194, Grade 2H for nuts.

2. SAE grade 5 bolts, studs and nuts.

3. SAE F436 hardened washers shall be used on all flange bolts behind the nuts.

C. Sleeves: Sleeves for foundation wall penetrations shall be fabricated of one-eighth inch (1/8") thick steel, with two inch (2") wide collar welded in place, and the assembly hot-dip galvanized.

D. Wall Penetration Seals: High temperature elastomeric link type mechanical seals compressed with corrosion-protected bolts and compression plates; Thunderline Link-Seal, no substitution.

E. Expansion Joints:

1. Expansion joints shall be slip tube type, controlled flex bellows (for steam) or externally pressurized type as designed for the specific location. They shall be 150-psig steam rating, flanged, and shall conform to the Standards of the Expansion Joint Manufacturers Association.

2. Bellows type joints shall have 316 ss bellows, and may be single or double bellows style as required for the intended service: Adsco, Hyspan, Pathway or Senior Flexonics.

3. Slip-tube type shall have external and internal high performance guides rated for 500ºF and designed for packing under pressure; Yarway or Hyspan.

4. Slip-tube joints shall be single or double type with center take-off taps as required for the given service.

F. Steam Traps for main line or building PRV assembly: Iron body, 3/4 inch diameter, inverted bucket type, Spirax Sarco B Series or Armstrong 800.

G. Automatic Air Vents (for high points on condensate systems): 3/4 inch threadolet with 3/4 inch gate isolation valve is required upstream of air vent. Air vent shall be 3/4 inch 150 # rating, Sarco 13W or approved equal. Discharge of condensate air vents in vaults shall be routed to the floor.

H. Strainers (for use on steam trap stations): Y-type with cast or forged steel body, 1/16 inch mesh Monel strainer elements, threaded for 2 inch and smaller piping.

I. Pressure gauges: Steam rated 3.5-inch dial, bourdon tube, 0 to 200 psig on steam mains, 0 to 50 psig on condensate mains, Ashcroft or equal. Include isolation valve and pigtail coil on steam gauges.

J. Steam main high point vents: Install isolation valve and thermostatic vent on steam main high points, Spirax Sarco VS-204 or equal. Vent discharge to floor.

VAULTS

A. All structures shall be of reinforced concrete. Main line junctions and service connections shall be in vaults, which require two openings. Minor assemblies such
as drip legs and/or expansion joints can be in pits, which require only one opening. See MAG Details 423, 424, 425 and 428.

B. Prefabricated or field-constructed vaults shall be provided with fresh air ventilation that will not allow rainwater to enter. Floors shall drain to sump hole.

C. Prefabricated concrete manholes shall conform to MAG Standards Section 505, 506, 725, 726, 727.

D. Ladders shall be provided according to MAG Standard Specifications, See Detail 428.

E. Covers and openings shall be marked STEAM.

**PIPING INSTALLATION**

**A. General**

1. Piping and pipe systems shall be fabricated, assembled, welded, installed and tested in accordance with ANSI B31.1.

2. Piping shall be cut accurately to field measurements and worked into place without springing or forcing, except where cold-springing is specified. Piping shall not be buried, concealed, or insulated until it has been inspected, tested, and approved. Flanged or Grooved joints shall not be concealed within walls or hard ceilings.

3. Materials and equipment shall be protected from the weather during construction.

4. Pipe runs underground between vaults shall be welded. Flanged and threaded joints shall not be buried.

5. Gaskets, packing, and thread compounds shall be suitable for the service. Joint compound or thread tape shall be applied to male threads only.

6. Arrangement of all piping shall be shown on the drawings. During installation, care shall be taken to avoid interference with other piping, conduit, and equipment. Lines shall be trapped only where shown on the drawings.

7. Reducing fittings shall be used for changes in pipe sizes. Bushings shall not be used.

8. In horizontal lines, two inches (2") and larger, reducing fittings of the eccentric type shall be used to maintain the bottoms of the lines in the same plane for steam, and the tops of the lines in the same plane for condensate.

9. Pipe shall be adequately supported and anchored so that strain from weight and thermal movement of piping is not imposed on piping, equipment, or structures.

**B. Pipe Expansion:**
1. Expansion of pipes shall be accommodated by expansion loops or L-bends in buried locations, or by slip or bellows expansion joints in manholes, tunnels and buildings. Expansion joints shall be set to ensure proper function and movement during system operation.

C Connections:
1. Locations of capped or plugged outlets for future connections shall be shown on the Drawings. Weld-o-lets or welded extra heavy fittings shall be used for tapping existing systems.

D. Steam Line Drainage:
1. For steam pipes in tunnels sloped down in the direction of steam flow at the ASU at the Tempe campus; a minimum of three inches per one-hundred feet (3” per 100’) of length is required. Where counter-flow of condensate must be accommodated in steam tunnels, lines shall be pitched up in the direction of steam flow six inches per one-hundred (6” per 100’) feet of length. Buried steam lines shall be pitched to accommodate the worst case of 6” per 100 feet. Steam lines may be peaked with lines pitched as above. Final pipe elevations must be recorded on the as-built drawings.

VALVE INSTALLATION
A. Valves shall be installed in accordance with ANSI B31.1 and ASME Section VIII.
B. Valves shall be installed as shown on the drawings and as required for proper functioning of the system.
C. Valve hand-wheels shall be installed in locations accessible from floor level, for operation and repair.
D. All flange bolts shall be lubricated with a high temperature bolt lubricant. Flanged bolt torquing shall be in an incremental staggered pattern to assure even compression of the gasket.

STEAM, CONDENSATE AND CHILLED WATER EQUIPMENT
A. Bottom connection shall not be allowed on steam, condensate, chilled and water systems. Condensate should not be at a 45 degree angle from top, but on a 45 angle to the flow.
B. All steam and condensate piping systems shall undergo a hydrostatic test of twice the operating pressure, with all equipment removed that may be damaged by excessive pressure.
C. The system shall be drained and blown down with 100 psi to remove any foreign particles.
Arizona State University

D. The condensate shall be flushed to drain during this process.

E. Only when the system is clean will the central plant receive condensate.
23 27 00  HEATING AND COOLING COILS

Design Standard

A. Hot water coils shall be of the distributing type with copper tubes, 0.035 inch minimum wall thickness and copper or aluminum fins. Chilled water cooling coils shall consist of copper tubes, 0.025 inch minimum wall thickness and copper or aluminum fins. No coils will have more than 12 fins per inch. All coils shall be easily replaced.

B. Coil ends shall have removable insulated casing panels. Coils shall have air vents that are automatic and that extend out of the casing so that they are accessible.

1. Automatic vent shall be piped to drain.

2. Isolation Valve shall be provided at each vent for service.

Each Air Handler/Fan Coil with a cooling coil will require a stainless steel condensate pan, drain and overflow drain. Design all coils for maximum face velocity of 450 FPM and all coils for a maximum of 8 rows.

C. Each coil shall be provided with fittings and valved to allow for mechanical flushing of coils in reverse direction. Provide drain for flushing at low end of coil connections. Provide 3/4 inch flush tees on supply and return. All coils shall have isolation valves installed on both supply and return.

D. Chilled water coils will be designated with a minimum 14°F rise; 8 row coils preferred. 6 row coils acceptable.

E. Coil connection details shall be as provided by ASU.

THERMOMETERS & GAUGES

A. Thermometers shall be of the industrial type with separable sockets.

B. Thermometers shall be shown on the drawings wherever temperatures of refrigerant or water are required for proper operation and servicing of the installation.

C. Pressure gauges shall be equal to Jas. P. Marsh Corp. "Quality" Type 4.

D. All gauges for a single system should be provided wherever required for proper operation, servicing or safety of the installation.

E. All equipment shall be provided with temperature and pressure indicators on both the inlet and outlet piping.
**23 37 13 REGISTERS AND LOUVERS**

A. All registers shall be double deflection type with adjustable horizontal and vertical control with opposed blade dampers. Base air outlet application on space noise level of NC 25 maximum unless noted otherwise. Double deflection blades shall be minimum 3/4 inch deep.

B. Acceptable manufacturers include Krueger, Titus, Tuttle and Bailey. Rate units in accordance with ADC standards. All grilles, registers and diffusers shall have baked enamel finish.

C. Diffusers shall have surface mount, spline or inverted T-bar type frame. Diffusers with a round neck shall be provided with a radial blade damper adjustable from diffuser face.

D. Louvers located on the exterior of the building shall be minimum 6 inch deep high performance type, with 1/2 inch inch mesh bird screen mounted inside.

**SHEETMETAL WORK**

**General**

Duct work and plenum chambers may be made of hot dipped galvanized steel, ASTM A120 for each side. Sheet metal work shall conform to practices established by ASHRAE, SMACNA, and the Uniform Mechanical Code.

**Design Standard**

A. Duct suspension shall be in accordance with SMACNA and hangers shall provide full clearance for all mixing boxes and items of repair or adjustment above ducts or ceiling.

B. Non-metallic duct work may be used only as specifically approved.

C. All duct exposure to the weather shall be made watertight by sealing each joint with approved sealant such as DP1010. Sealant shall be applied to all longitudinal and transverse joints/seams. Air conditioning duct shall have 1-1/2 inch rigid insulation and cover with watertight aluminum or galvanized steel sheet. All other duct transverse joints/seams will be sealed air tight with DP1010 duct sealant or other approved sealer.

D. No flexible duct runs over 7 feet in length.

E. All flexible duct must be at least as large as the diffuser neck size.

F. Do not make 90 degree changes in direction with flexible duct.

G. Lap metal ducts in direction of air flow.

H. Provide flexible connections immediately adjacent to equipment in ducts associated with fans and equipment subject to forced vibration. Flex connections shall be neoprene coated glass flameproof fabric approximately 4 inch wide tightly crimped into metal edging strip and attached to ducting and equipment by screws or bolts at 6 inch intervals. Flexible connections exposed to sunlight or weather, provide hypalon coated glass fabric.
23 55 00 GAS FIRED HEATING UNITS

Description

Gas fired heating units under either heating and air conditioning or plumbing work should be provided with all necessary safety devices.

General

A. All gas fired equipment shall be provided with factory installed electronic ignition.

B. An electrically operated control valve shall be provided which will close, shutting off gas to the burners, in the event that the temperature in the heater should rise above a safe point.

C. A gas pressure regulator shall be provided to maintain correct gas pressure at the burners.

D. A manual shut off valve shall be provided to shut off all gas service to the heating unit. This valve should be a safe distance from the burners.

E. Gas fired steam boilers shall be equipped with safety devices as described above, and in addition, shall have a high and low water alarm and fuel shut off system similar or equal to the McDonnel and Miller.

F. Each piece of gas fired equipment shall be vented in accordance with the latest Uniform Mechanical Code edition.

BOILERS

A. All boilers shall have guaranteed efficiency of 80% or greater over the designed operating range and shall be for producing hot water or steam.

B. All boiler packages shall receive factory tests to check construction operation and function of all controls. All shop tests may be witnessed by the purchaser.

C. All boilers shall have factory authorized start-ups. The service representative shall furnish a complete start-up report, including a combustion test report and other information that is needed to ensure operation per manufacturer's and design specifications. Owner training shall include and service representative shall be on site for a minimum of two consecutive days.

D. The entire boiler base frame and other components shall be factory painted before shipment with a hard finish enamel. A minimum of two lifting eyes shall be located on the top of the boiler.

E. Observation ports for the inspection of flame conditions shall be provided at each end of the boiler.
F. Steam boilers shall be provided with feedwater pump control with low water cutoff and a water column located on the side of the boiler.

G. The generator vessel shall be constructed in accordance with the ASME Code and inspected and rated for PSI. ASME relief valve shall be provided on all boilers and rated for that application.

H. The boiler safety controls and trim shall be factory mutual (FM). The FM Inspection Certificates shall be furnished. Each boiler shall be UL listed, and must display the UL listing label on the boiler showing the unit approved as a complete package boiler assembly.

I. The safety controls and trim shall include, but not be limited to, primary and secondary positive close motorized gas valves, main gas cook and gas pressure regulator, manual "proof of leak" test cock downstream of all gas controls, high/low MR gas pressure switches, instantaneous, solid state flame safeguard with manual reset, automatic electronic ignition, intermittent pilot, 8/10 second flame response, 15 second flame failure lockout, normally open vent valve, operating temperature control, low water cutoff, temperature pressure gauges, and factory supplied barometric damper. Control panel doors shall be hinged and lockable.

J. Provide outside air reset controller for automatically resetting supply water temperature in accordance to ambient temperature.

K. Boilers shall be mounted on a 4 inch thick concrete housekeeping pad.

23 60 00 BUILDING SPACE COOLING/REFRIGERATION EQUIPMENT

Description

Consideration should be given in the case of large systems to the installation of more than one condenser or chiller unit with a total capacity greater than designed capacity and with piping arranged so that any one unit may be shut down for repair, during light loads, and the system operate on remaining capacity.

Design Standard

A. Because of the production limits and excise taxes applied to organic chlorine freons (CFC's), the selection of the system shall include:

1. An assessment of availability of refrigerant; R-12 refrigerant will not be used in any equipment. R-22 refrigerant will only be allowed in equipment with life expectancy until the year 2020. R-134A refrigerant is required for Central Plant equipment.

2. O & M costs.

3. Future conversion to substitute refrigerants; R-134A/R41-A or FR-12/R416A preferred.
4. The life cycle cost analysis shall dictate system selection.

B. In cases where special requirements are requested, such as ventilation, volatile solvents, or inflammable liquid use in the refrigerated area, the additional requirement shall be discussed with the ASU design team.

C. All equipment shall be specified by manufacturers catalog number, together with sufficient design requirements to enable checking of specified equipment and equipment other manufacturers.

CONDENSERS

A. Air Cooled:
   1. Should only be used where cooling water is difficult to obtain, restricted in use, or expensive.
   2. If used, they shall be located in a well ventilated space, with mechanical ventilation, if required.

B. Water Cooled (shell and tube type):
   1. For ASU at the Tempe campus, should only be used with all compressors of 1HP and larger. A recirculated cooling tower system is required. No City water shall be used for equipment cooling.
   2. For ASU at the Polytechnic campus, chilled water based cooling is preferred. The use of cooling towers is preferred. New housing is to be integrated into the campus core, and; sound levels should have a high priority on equipment selection.

C. Control Diagrams:
   1. Complete electrical and automatic control diagrams shall be shown on the plans together with identification and operation of each control.

REFRIGERATION PIPING & FITTINGS

A. All refrigerant piping shall be OD hard drawn copper pipe type K or L, cleaned, deoxidized, dehydrated, sealed by the manufacturer before shipment.

B. All ends shall remain sealed at all times until used.

C. Fittings and flanged unions shall be cast brass or wrought copper refrigeration type fittings.

D. Cast fittings shall be internally tinned before use.

E. Chilled water or cooling water piping shall be type "L" or type "K" copper tubing and cast brass fittings of the solder type.
F. Copper tubing joints in refrigerant lines shall be made with Handy & Harmon "Sil-Fos" brazing alloy and "Handy Flux" or equal. Copper tubing/pipe shall be filled with nitrogen during the brazing process.

G. All surfaces to be joined must be thoroughly cleaned. When soldering stop valves or solenoid valves, wrap the valves with moist fabric to absorb excessive heat.

H. Stop valves should be partly open.

I. When soldering thermal expansion valves or suction pressure regulating valves, remove power assembly to prevent damage by excessive heat.

J. Screwed joints shall be brazed or made up with a paste of freshly mixed litharge and glycerin.

K. Use care to apply paste to male connections only after entering 1 1/2 to 2 threads.

L. Screwed joints will be approved only where brazing fittings cannot be used.

M. Penetrations of insulated walls, ceilings or floor of controlled environment rooms by pipes, conduits or other mechanical equipment shall be detailed on the plans.

N. In the particular case of cold rooms, where moisture migration could occur, the detail must include a suitable reliable means for maintaining the continuity of the vapor barrier.

O. All penetrations must be vermin proof.

P. Piping Arrangements

1. All refrigeration piping must be shown on the contract or working drawings to scale and in both plan and elevation views.

2. All devices for preventing or controlling the accumulation of oil must be shown and specified including oil traps, double riser systems and the pitching of refrigerant lines.

3. Multiple evaporator and/or compressor units, piping connections shall be arranged to prevent gravity flow of oil or liquid refrigerant into the idle units.

4. Oil traps in suction lines should not be located near the compressor sections.

5. Piping shall be sized on the drawings.

6. Hot gas and suction velocities shall be not less than 75-fpm in horizontal lines and 1500 fpm in vertical lines.

7. When capacity control is used, double pipe fixtures and oil traps should be used to avoid dropping below 1500 fpm in vertical lines.

8. In sizing suction lines, it will be found generally desirable to limit the pressure
drop to one 1 psi.

**DRYERS**

A. A liquid dryer with 3 valved by-pass shall be installed in the liquid line from each receiver.

B. Extra cartridge shall be furnished for each dryer.

**REFRIGERANT & OIL**

A. The contractor shall furnish sufficient refrigerant to charge each system.

B. The amount charged shall be permanently stamped on the receiver or the compressor.

C. Systems shall be fully charged at time of acceptance.

D. The contractor shall furnish additional amount of refrigerant that may be required during the guarantee period due to repairs.

E. The contractor shall make all replacements or adjustments that may be required under the guarantee provisions.

F. The same requirement shall apply to compressor lubrication oil, except that amount charged need not be posted.

G. All refrigerants and oils shall conform to all federal regulations and be designed to be used in that type of equipment.

**RECEIVERS**

A. Receivers shall be fitted with armored sight glasses with ball check gauge valves.

B. Receivers shall be fitted with drain valves accessibly located and fitted with hose coupling threads.

**SHOP DRAWINGS**

A. Shop drawings shall be submitted for:

1. Refrigeration compressors, cooling towers, condensers, receivers, fans, pumps, evaporators, oil separators or traps, heat exchangers, control diagrams, control panels, structural supports or bases and vibration absorbers.

**TESTS**

DEHYDRATION & AIR REMOVAL

A. Refrigeration systems must be thoroughly dehydrated and evacuated before charging with refrigerant.

B. Systems should be evacuated with a vacuum pump to an absolute pressure of not more than 0.1 inch mercury.

C. Dryer cartridges must be replaced until all water has been removed.

INSTRUCTIONS

A. The contractor shall furnish typewritten operating instructions, and these shall be mounted behind glass in the compressor room.

B. Information shall be adequate to start and stop equipment, charge oil and refrigerant, removal of non-condensible gases, and all other information necessary to operate systems in a safe and efficient manner.

C. The pressure and temperature settings of all controls shall be personally instructed in the proper maintenance and operation of the system.

D. Service telephone numbers shall be posted with the operating instructions.

PIPING INSULATION

A. Suction lines will be insulated in all areas with a material of closed cell foamed rubber plastic flexible tube.

B. Wherever possible the insulation shall be installed in tube form.

C. All joints shall be sealed by use of an approved adhesive, and continuous insulation through walls, floors, partitions, etc., will be required to effectively form a complete vapor seal.

D. Valves and fittings will be insulated as above with material cut and formed to fit, and applied to give a neat, finished appearance.

E. Insulation shall be painted with an approved paint in areas exposed to sun light.

CHILLERS

A. Chillers shall be rated in accordance with the latest ARI standards.

B. The power input shall not exceed the specified KW. Submit performance data as specified at the end of this section.

C. Units shall be a complete factory package including compressors, motor, cooler, condenser, refrigerant, flow control, purge unit and/or transfer unit, refrigerant storage receiver and control center with related unit mounted controls. Chillers under 100 tons in capacity shall be equipped with scroll or reciprocating type
compressors.

D. Each unit shall be factory assembled, piped, wired, leak tested and painted. Manufacturer shall provide initial charge of oil and refrigerant.

E. Compressor shall be statically and dynamically balanced and over-speed tested. Automatic capacity reduction shall be provided and capable of modulating capacity from 100 percent to 10 percent of full load. Proof of performance shall be provided at close-out of project.

F. The lubrication system shall supply oil to all shaft seal, compressor journals, bearing and all moving parts requiring lubrication. A replaceable external oil filter with provisions for servicing without removing the refrigerant charge. Oil heaters shall be furnished and lubrication system shall be factory installed and piped.

G. Motor full-load amperes (FLA) at design condition shall not exceed motor nameplate rating.

H. Hermetic motors shall be continuous duty, induction type, fully assembled and factory tested.

I. Open motors shall be continuous duty, squirrel cage induction type, fully assembled and factory tested with open drip-proof enclosure.

J. The evap. condensor shall be of the horizontal shell-and-finned-tube design, fabricated so each tube may be individually replaced. Water boxes shall be provided with removable covers for tube inspection and maintenance. Shells shall be designed for the refrigerant working pressure and ASME certified. Relief devices shall be provided on the refrigerant side in accordance with ANSI safety code. Multiple relief devices shall be brought to a common vent to atmosphere.

K. Chillers that operate at sub atmosphere pressures shall be provided with a complete purge unit, providing positive means for collection, return of refrigerant and removal of noncondensables. The purge unit shall be fully automatic in operation. It shall provide a means to signal the operator at occurrence of excessive purging, indicating an abnormal air leak into the unit. The purge unit shall include necessary operating controls, piping, and refrigerant valves to isolate the purge unit from the chiller. The purge unit shall be factory mounted and wired.

L. Units operating above 15 psi shall be provided with a transfer unit and storage receiver to permit transfer and isolation of the full refrigerant charge. The storage receiver shall be ASME core constructed, stamped, and furnished with relief devices in accordance with the ANSI safety code. The transfer unit and receiver shall be furnished with all necessary controls for manual operation and shall be factory mounted, piped and wired.

M. Each chiller shall be furnished with a complete digital control center in a lockable enclosure, factory-mounted, piped and wired, with direct interface connection to campus EMS system. Means of communication shall be through an open protocol system without the use of an interpreting device.
N. A factory trained field representative shall supervise the final leak testing, charging and initial start-up. The owner training shall be provided to instruct in the proper care and operation of the unit for a period of five (5) days.

O. All chiller tubes that are double enhanced shall be upgraded to a minimum of .035 inch thickness.

Chiller Performance Data can be recorded on the following page.
Chiller Performance Data Worksheet

Manufacturer: __________________________ Model: __________________________ Compressor Type: __________________________

Chiller Energy Consumption

<table>
<thead>
<tr>
<th>Average Load (tons)</th>
<th>Average Chilled Water Temp.</th>
<th>Average Condensor Water Temp.</th>
<th>Compressor kw@load</th>
<th>Operating Hrs./Yr</th>
<th>Annual KW Consump.</th>
</tr>
</thead>
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<tr>
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<td>40º F</td>
<td>85º F</td>
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<td>600</td>
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<td>______ x</td>
<td>2,500</td>
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<td>65º F</td>
<td>______ x</td>
<td>1,500</td>
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<td>40º F</td>
<td>60º F</td>
<td>______ x</td>
<td>500</td>
<td>______</td>
</tr>
</tbody>
</table>

TOTAL ANNUAL CHILLER KW CONSUMPTION  = ______

Part Load KW Usage at Design

KW @ 10% load  = ______
KW @ 20% load  = ______
KW @ 30% load  = ______
KW @ 40% load  = ______
KW @ 50% load  = ______
KW @ 60% load  = ______
KW @ 70% load  = ______
KW @ 80% load  = ______
KW @ 90% load = ________
COOLING TOWERS

A. Casing and louver shall be constructed with hot dip galvanized steel or non-asbestos containing composite material.

B. Cold water basin shall be one piece welded design with heavy gauage stainless steel floor and SOEs provided with depressed center section, cleanout, drain fitting, bottom suction outlet, suction screen, anti-cavitation device, and make-up water valve.
23 73 00 AIR HANDLING

FANS AND DRIVES

Depending on application, air foil or plug fans are preferred over forward curve or vane axial fans. This preference is based on noise and control range of fans in a university environment.

1. Generally belt drives shall be used with "V" belts, using "A" and "B" section belts, provided with adjustment capability for tension and alignment. Multiple belts shall be factory matched sets.

2. A metal tag showing manufacturers model number, size and style of replacement belt set shall be attached to each belt guard. Belts shall be rated at 150% of the motor horsepower.

3. Sheaves shall be statically and dynamically balanced close grain cast iron free of sand holes or other defects.

4. For fan motors up to 25 HP they shall be adjustable pitch for air flow balancing purposes only, final position should be replaced with a standard sheave with the driven sheave being a matched companion sheave by the same manufacturer.

5. No fan/blower RPM shall exceed the drive motor RPM.

6. Required initial design setting of the variable pitch sheave to be at the mid-point.

7. Air handlers shall be sized for a maximum motor size of 40 horsepower. Motor sizes in excess of 40 horsepower shall be approved by ASU.

GENERAL

A. Specified fans shall have Air Moving and Conditioning Association (AMCA) approved certification rating.

B. All connections between fans and duct work shall be with a flexible section.

C. All accessible inlet or exhaust opening in fans shall be specified to include 1/4 inch x 1/4 inch wire mesh guards covering those openings as well as belt and pulley guards, unless easily accessible for cleaning.

D. Exhaust fans are to discharge upward. Discharge duct is to extend 7 feet above the roof with 1/2 inch x 1/2 inch mesh covering. Fan housing shall have drain or at least three 3/8 holes in bottom of housing for drains. Any and all equipment to be mounted on roof shall be mounted on a platform that is a minimum 10 inches above surrounding roof and that has been roofed and flashed.
E. Blowers and fans 18 inch in diameter and over shall be dynamically balanced. Vibration and noise shall be limited to acceptable levels at rate RPM. These shall be as established by ASME, SAE, and AMCA for the areas served.

F. All plenums and areas shall be accessible by entrance doors, panels, or moveable sections, and shall have lights and convenience outlets for servicing and making repairs within the enclosures.

G. All equipment rooms containing heating and air conditioning equipment shall have lights, convenience outlets and water supply with drain.

H. The maximum RPM for all utility fans shall be 1800 rpm. If a fan cannot be selected within this range, select type of fan that is specifically designed to operate at higher rpms such as radial blade type power fans.

I. All the discharge ducts shall extend 7' above finished roof.

J. Fan Drives:

1. For variable-air-volume applications, variable frequency drive (VFD) control shall be utilized.

2. The VFD shall be capable of operating any standard NEMA Design B squirrel cage induction motor (rated for 480 volt, 3 phase, 60 HZ with a service factor of 1.15) with full load amperage rating between 10% and 110% of the full load current capability without requiring any modifications to the motor or drive.

3. Low speed limit with minimum speed adjustment: 6-40Hz; high speed limit with maximum speed adjustment: 40-60Hz.

4. The maximum speed of the motor shall not exceed motor rated RPM. Speed range of a minimum of 5:1 is acceptable, 10:1 is desirable.

5. Acceptable manufacturers are Toshiba, ABB, Cutler, and Hammer.

6. V-belt drives shall be rated at not less than 150% of motor nameplate rating.

7. Motor drives requiring one (1) belt shall be provided with adjustable pitch motor sheaves, with the midpoint of the adjustment range equal to the specified RPM required for the fan.
AIR HANDLING UNITS

A. Air handling units shall be in accordance of Air Conditioning and Refrigeration Institute (ARI) standards.

1. All sectionalized cabinet modules and accessories shall be constructed of mill galvanized sheet metal, formed and reinforced to provide a rigid assembly. Formed panels shall be removable to provide easy access to internal components.

2. All fan and coil sections shall be insulated with min. 1 inch thick - 1.5 pcf density glass fiber insulation with a black flame-resistant coating. The insulation shall be affixed to the casing with waterproof adhesive and permanent fasteners. The insulation and adhesive shall meet the flame and smoke generation requirements of NFPA-90A.

3. Drain pans shall be of heavy gauge welded galvanized steel and drain connections shall be provided on both sides of the pan. Drain pans shall have an inner pan (double drain pan) with min.1 inch thick, 1.75 pcf density insulation sandwiched between pans. The drain pans shall extend completely under the fan and coil section.

4. Coil sections must have tracks extended the full width of the unit and depth of coils to provide easy removal of service and maintenance.

5. Fan bearings are to be self-aligning, pillow blocks, of flange-type regreaseable ball bearings with standard hydraulic grease fittings extended to outside of each drive.

6. Fan shafts shall be solid core and selected to operate well below the first critical speed. Fan wheels and shafts shall be designed for continuous operation at maximum rated speed and motor horsepower. Fans and shafts shall be statically and dynamically balanced as an assembly. Drive shall be selected for a 1.2 or 1.5 service factor. Fans shall be internally isolated. Hollow shafts are acceptable over 25 hp.

7. Drive motors shall be premium eff. Open drip proof or with ASU approval totally enclosed fan cooled mabe be used.

8. Cooling and heating coils shall have certified performance in accordance with ARI standards. Cooling coils shall be arranged in the unit for vertical or horizontal air flow.

9. Coil casing to be constructed in accordance with section 23 27 00, "Heating and Cooling Coils."

10. Air filter shall be accessible from either side with hinged access doors. Filters shall be in accordance with Section 23 73 00 with a maximum face velocity of 450 FPM.
B. Exhaust/Supply Fans

5. Exhaust/supply fans shall be direct drive or v-belt drive. Fans and drives shall be internally isolated.

6. Fan bearings for utility type fans shall be self-aligning. Pillow block, regreasable ball bearing type. Grease fittings shall be extended to outside of drive.

AIR DISTRIBUTION

In laboratory type buildings, or similar buildings where exhaust air may be contaminated, the building air supply should generally be taken low on the windward side and exhaust should be at the highest point of the building and directed upward, to prevent re-entry.

General

A. Louvered openings must be arranged to prevent rain from entering duct system.

B. Design should accommodate required air flow without excessive noise or pressure drop.

C. Provide 1/2 inch bird screening to avoid entry of debris. Maximum inlet duct velocity shall be 500 FPM.

D. Do not locate exhaust outlets where air will discharge on plantings. (Such plantings will not survive continuous air currents.)

E. Do not place grilled openings inside a building in corridor doors where the corridor wall must have a fire rating.

F. Industrial exhaust systems for woodworking machinery, grinders, dust collecting, paint spraying, etc., shall be designed with adequate provision for entrapment and safe removal of any material.

G. In general, canopy type hoods should be designed for an air quantity arrived at by multiplying the total plan view face by a velocity of 100 fee per minute. This will apply to canopy hoods used over cooking equipment in kitchens. Where this results in excessive air quantities, other types of hoods, including local exhaust slots should be investigated. Industrial ventilation guidelines should be used for non standard type hoods.

H. Cafeteria kitchen hoods shall be of stainless steel, and range hoods such as used in apartments, faculty lounges, etc., shall be the typical hood designed to fit with the surrounding decor with stainless steel liners. The grade of stainless steel used shall be type 304 for welded hoods and type 302 for formed hoods.

I. Ducts shall be constructed of stainless steel, welded seam and joints, and so designed to effectively carry contaminated air to the atmosphere.
J. Access panels shall be provided at all elbows and elsewhere as required to allow for cleaning the entire duct system.

K. A system for extinguishing fires using steam or 180° F hot water is desirable.

L. Canopy hoods, where grease or other inflammable substances are collected by the filters, shall have suitable collection points easily accessible and cleanable.

M. Care must be taken to insure an adequate supply of tempered air whenever the hood exhaust fans are operating. This may consist of local, window mounted, unit ventilators or may be a central system in the building.

N. See Division 11, section 11 53 13 for laboratory hood systems and requirements.

**DAMPERS**

A. Dampers shall be provided in all duct systems to permit balancing of air quantities, and to maintain fire ratings at wall, floor and ceiling penetration.

B. Each supply outlet and each exhaust branch must have a damper control.

C. The main duct run must be dampened to permit proper division of air quantities in the duct systems.

D. Damper controls to be accessible without the removal of panels or other obstructions.

E. Dampers shall be locking quadrant type and indicate open or closed position. They shall be accessible.

F. Dampers which are integral parts of supply or grilles may be used for air balancing provided they are not so located in the duct system that the adjustment required will cause noise in occupied areas.

G. Fire and smoke dampers shall have a UL classification and be installed in accordance with UL Safety Standard 555, Uniform Building/Fire Codes, NFPA 90A, and SMACNA, and be removable with respect to duct inspection and/or cleaning.

H. Fire dampers shall be spring loaded curtain type (no multiple blade type) and shall not restrict the effective cross sectional area of the duct in which it is installed. Installation per National Fire Protection Association Pamphlet 90 B.

I. Balance dampers must be accessible for inspection and have continuous control rods, and shall be fabricated from galvanized steel, minimum 16 gauge metal.
J. Rectangular control dampers shall be multi-blade damper of opposed blade pattern with maximum blade size 12 inches by 72 inches. Assemble center and edge crimped blade in prime coated and galvanized channel frame with suitable hardware. Provide side mounted key operator where not readily accessible. Operator shall be marked "no flow" and "full open."

K. Round ducts shall be provided with manual single blade dampers with operators attached to side of duct. When not readily accessible, provide with right angle work gear regulator for remote operation.

AIR FILTERS

A. All heating, ventilation and air conditioned air shall be filtered.

B. All air shall be filtered during construction.
   1. Construction filters shall be replaced during construction as needed to protect the cleanliness of the equipment.
   2. Construction filters shall be replaced at the time the Owner accepts the building as complete.

C. Acceptable filter manufacturer: Camfil-FARR or equal.

D. Filter racks will be fabricated to withstand max. velocities and volume of air handler(s) to be served.
E. Size filter racks to receive one or more of ASU stock sizes:

<table>
<thead>
<tr>
<th>ASU STOCK #</th>
<th>SIZE</th>
<th>DESCRIPTION</th>
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E. Camfill-Farr “Durafil” filters are preferred for final filters. Final filter racks shall be fabricated to accept “Durafil” filters.

**ACCESS DOOR PANELS**

A. Access doors shall be provided as necessary to permit access to plenums, filters, coils, bearing, blowers, control dampers and motors, valves and fire dampers.

B. All air handling units shall be provided with access doors and panels.

C. Blower Section:
1. Blower sections with motors and/or bearings within the blower casing shall be provided with hinged access doors in the side or top adjacent to the side;

2. Minimum size 36 inch x 24 inch.

D. Blower Discharge Section:

1. Blower discharge section or entering air side of the coils shall be provided with hinged access doors in the side of the air handling unit;

2. Minimum 24 inch x 14 inch.

E. Leaving Side of Coils:

1. Plenums on the leaving side of the coils shall be provided with access panels in the side or front of the unit on cooling coil and in the side or between hot and cold decks for the heating coil;

2. Minimum size 20 inch x 12 inch.

F. Access Doors:

1. Constructed of not less than 18 gauge galvanized or bonderized enameled steel and hinged on not lighter than 18 gauge mounting frame;

2. Provide neoprene rubber or felt gasket riveted or stapled to door and one inch acoustical insulation securely pinned to door with smooth finished edges;

3. Provide vent lock No. 260 or equal latches;

4. One on doors up to 24 inch high, two on larger doors.

G. Access Panels:

1. Constructed of not less than 16 gauge galvanized or bonderized enameled steel, bolted with machine bolts to nuts spot welded to casing on not over 6 inch centers;

2. Provide neoprene, rubber or felt gasket riveted or stapled panel and 1 inch acoustical insulation securely pinned to door with smooth finished edges.

**DUCTS**

1. Based on requirements, the duct system will be of the single duct application, of the single or multi-zone use. The system shall be properly zoned and regulated to meet the anticipated needs of the occupancy of each zone. The duct system will be insulated per insulation schedule.

2. Fiberglass duct board will not be permitted.

3. Sufficient exhaust of air to be provided to insure proper circulation of fresh air
and the maximum air change desired for room usage in accordance with the most recent ASHRAE standards.

4. All existing and new HVAC ductwork will be evaluated by the design engineer to determine if a control system is needed to prevent over-pressurization of ductwork.

5. New HVAC ductwork systems shall be designed and evaluated as a whole new system.

6. The ductwork system shall not be considered substantially complete without full testing and acceptance of the ductwork air pressures and control sequence operation.

7. Capital Programs Management Group representative shall be present during all testing.
DIVISION 25 - INTEGRATED AUTOMATION

25 51 00 FACILITY MANAGEMENT SYSTEM

PART 1 GENERAL REQUIREMENTS

SECTION INCLUDES

A. Facility management system for ASU at the Tempe campus is outlined in this section. Facility management systems at other campuses shall be in accordance with requirements herein with guidance from Capital Programs Management Group.

B. ASU at the Polytechnic campus has 3 manufacturers of control system at the present time (Johnson, Alerton and Automated Logic). It is preferred that any future systems be limited to one of these 3 manufacturers.

RELATED WORK SPECIFIED IN OTHER SECTIONS

A. Where work specified under other Sections of these Specifications connects to equipment or systems which is a part of this Section, provide proper connection(s) to such equipment including trade coordination. The following sections may have direct links to the installation of the FMS system:

B. Section 00000 - General Conditions

C. Air Terminals

   1. All costs associated with factory mounting of DDC controllers shall be the responsibility of the VAV Box supplier.

D. Division 26 - Electrical Work

   1. 120 volt power to DDC controllers is the responsibility of the Division 26000 contractor.

DEFINITIONS

A. Facility Management System (FMS): The entire system of hardware and software specifically designed to centrally manage building HVAC and related utilities. The FMS includes the DDC subsystem, open system ports, and open protocol bus or integrators and network routers for connection to information networks.

B. FMS Contractor: The Facility Management System Contractor responsible for the installation of the Facility Management System specified herein.
C. Control Wiring: Includes conduit, wire and wiring devices to install a complete Control System including motor control circuits, interlocks, thermostats, PE and EP switches and like devices. Includes all wiring from a DDC cabinet to all sensors and points defined in the Points List summary or specified herein and required to execute the sequence of operation. Includes necessary power wiring to all FMS devices, digital controllers including terminal units and actuators.

D. Distributed Control: A system whereby all control processing is decentralized and independent of a central computer. The control system is built up of stand-alone controllers. A single controller failure shall not impact more than one system.

E. Network: A system of distributed control units that are linked together on a communication highway. A network allows sharing of point information between all control units. Additionally, a network provides central monitoring and control of the entire system from any distributed control unit location. First tier networks shall provide “Peer-to-Peer” communications. Second tier networks shall provide either “Peer-to-Peer”, Master-Slave or Supervised Token Passing communications.

F. The term “provide” means “provide complete in place”, that is, furnished and installed and ready for operation and use.

QUALITY ASSURANCE

A. General

1. The Facility Management System (FMS) herein specified shall be fully integrated and installed as a complete package by Johnson Controls, Inc.- Factory Branch Office. The System shall include all wiring, piping, installation supervision, calibration, adjustments, and checkout necessary for a complete and fully operational system.

2. The Facility Management System Contractor shall be a factory owned branch office that is regularly engaged in the engineering, programming, installation and service of Facility Management Systems of similar size and complexity.

3. The FMS Contractor shall have a local branch facility within a 50-mile radius of the job site. Emergency service shall be available on a 24-hour, 7-day-a-week basis.

4. The FMS Contractor shall be responsible for all work fitting into place in a satisfactory and neat workmanlike manner acceptable to the Owner/DP.

5. The FMS Contractor will coordinate with other Trade Contractors regarding the location and size of pipes, equipment, fixtures, conduit, ducts, openings, switches, outlets, and so forth, in order to eliminate any delays in the progress of the job.
B. Experience Record

1. The FMS Contractor shall have a minimum of ten years experience with the complete, turnkey installation of Facility Management Systems of similar size and technical complexity.

2. The FMS Contractor shall employ specialists in the field of Facility Management Systems including: Programming, Engineering, Field Supervision, and Installation. Specialists shall have a minimum of five years of experience with Facility Management Systems.

C. Products

1. The Facility Management System architecture shall consist of the products of a manufacturer regularly engaged in the production of Facility Management Systems, and shall be the manufacturer's latest standard of design. Controllers and DDC (Direct Digital Control) system components shall be current production products.

2. All other equipment shall be the products of the FMS manufacturers or of an approved manufacturer regularly engaged in production of specialized Facility Management System materials or equipment.

3. The Facility Management System will connect to the existing Johnson Controls, Inc. Metasys Facility Management System and Johnson Controls, Inc. Metasys operator workstation located on campus.

D. Governing Code Compliance

1. The FMS Contractor shall comply with all current governing codes ordinances and regulations, including UL, NFPA, the local Building Code, NEC, and so forth.

WORK BY OTHERS

A. Mechanical Contractor:

1. Installation of automatic control dampers, smoke control dampers, and necessary blank off plates.

2. Access doors where and as required.

3. Installation of immersion wells and pressure taps.

4. Installation of flow switches.

5. Installation of automatic control valves.


7. All mechanical submittal data for equipment to be controlled by this section shall be provided by the Division 23 contractor for use in preparation of the Direct Digital Control System submittal.

B. Electrical Contractor:
1. Installation of 120 vac power to DDC controllers shown on the electrical drawings shall be the responsibility of the Division 26 contractor.

2. Installation and power wiring of all Variable Frequency Drives (VFD’s) provided under this section shall be the responsibility of the Division 26 contractor. Start-up will be provided under section 25 51 00. VFD’s shall be Metasys N2 compatible.

3. All magnetic starters furnished by Electrical Contractor for mechanical equipment shall be furnished with integral 120 volt control transformers, sized to handle the additional VA needed for the controls – pilots, EP valves, etc.

Electrical Work for Controls:

A. Complying with the principle of “unit responsibility” all electrical work for automatic controls, except as otherwise specified, or shown on the electrical drawings shall be included in Division 23.

b. Electrical work shall, in general, comply with the following:

1. All low voltage wiring in finished rooms shall be concealed below working heights and exposed above.

2. Electrical work may include both line voltage and low voltage wiring as required.

3. Conduit network for power systems may be used for running control high voltage wiring.

4. All electrical work shall comply with the N.E.C. and local electrical codes.

5. All safety devices shall be wired through both hand and auto positions of motor starting device to insure 100% safety shut-off.

6. All magnetic starters furnished by Electrical Contractor for mechanical equipment shall be furnished with integral 120 volt control transformers, sized to handle the additional VA needed for the controls – pilots, EP valves, etc.

7. The motor starter supplier shall provide auxiliary contacts as required for interlock by FMS contractor, the supplier shall estimate an allowance of at least one auxiliary contract per starter. All interlock and control wiring shown on the electrical prints is by the electrical subcontractor.

8. Low voltage plenum rated wiring can be run exposed above an accessible ceiling. Wiring shall be neatly tied to pipes, EMT, or other devices and not laid on ceiling tile. All wiring in mechanical or electrical rooms shall be in conduit.
9. All devices must be enclosed. If a cover is not part of a device, it must be mounted in a separate enclosure.

10. Each DDC controller must have an independent switch to disconnect power.

WORK INCLUDED

A. Installation of Facility Management System (FMS)
   1. The FMS Contractor shall furnish and install a complete Facility Management System (FMS) for all mechanical systems and other facility systems as included in the project documents. The FMS will provide the functional features as defined in Part 1-General Requirements, Part 2-Products, and Part 3-Execution of these Specifications. The FMS Contractor shall provide a complete and operational system to perform all sequences of operations as per ASU specifications.

   2. All device locations shall be safe from water damage. No control devices including VFD’s will be mounted under piping, valves or wall penetrations where water leakage or other damage may occur.

   In addition, the following apply:
   a. The work under this Section shall include all materials and labor to perform all work required for the installation of the FMS as specified.
   b. The drawings and Specifications are complementary to one another—meaning that what is called for on one is to be considered called for in both. Where conflicts exist between the Specifications and/or drawings, the more stringent requirement shall apply.
   c. The FMS Contractor shall be responsible for field verification of site conditions and for gathering all necessary field data for all items to be provided under this contract prior to submitting his or her bid.
   d. Where work specified under other Sections of this Specification connects to equipment or systems that are listed and described in this Section, the FMS Contractor shall provide proper connection(s) to such equipment, including trade coordination.

SUBMITTALS

A. Shop Drawings, Product Data, and Samples
   1. The FMS Contractor shall submit within 60 days after award installation drawings and control strategies for review.
2. Each submittal shall have a cover sheet with the following information provided: submittal ID number; date; project name, address, and title; FMS Contractor name, address and phone number; FMS Contractor project manager, quality control manager, and project engineer names and phone numbers.

3. Each submittal shall include the following information.
   a. FMS riser diagram showing all DDC controllers, operator workstations, network repeaters, and network wiring.
   b. One-line schematics and system flow diagrams showing the location of all control devices.
   c. Vendor’s own written description for each sequence of operations, to include the following:
      1) The sequences of operations provided in the submittal by the FMS contractor shall represent the detailed analysis needed to create actual programming code from the design documents.
      2) The sequence of operations shall cover normal operation and operation under the various alarm conditions applicable to that system.
   d. Detailed Bill of Material list for each panel, identifying: quantity, part number, description, and associated options.
   e. Control Damper Schedules. This spreadsheet type schedule shall include a separate line for each damper and a column for each of the damper attributes, including: Code Number, Fail Position, Damper Type, Damper Operator, Blade Type, Bearing Type, Seals, Duct Size, Damper Size, Mounting, and Actuator Type.
   f. Control Valve Schedules. This spreadsheet type schedule shall include a separate line for each valve and a column for each of the valve attributes, including: Code Number, Configuration, Fail Position, Pipe Size, Valve Size, Body Configuration, Close off Pressure, Capacity, Valve CV, Calc CV, Design Pressure, Actual Pressure, and Actuator Type.
   g. Cataloged cut sheets of all equipment used. This includes, but is not limited to, the following: DDC panels, peripherals, sensors, actuators, dampers, control air system components, and so forth.
   h. Hardware data sheets for all operator workstations, local access panels, and portable operator terminals.

4. FMS Contractor shall not order material or begin fabrication or field installation until receiving authorization to proceed in the form of an approved submittal. FMS Contractor shall be solely responsible for the removal and replacement of any item not approved by submittal at no cost to the Owner.

5. Hardware, Shop Drawings, and Software submittals shall be provided to ASU Building Automation Systems Services for approval prior to installation.
O&M MANUALS

1. Submit two sets of each manual: one electronic copy on CD, and one printed hard copy.
   a. Include the following documentation in the Hardware Manual:
      1) General description and cut sheets for all components.
      2) Detailed wiring and installation illustrations and complete calibration procedures for each field and panel device.
      3) Complete trouble-shooting procedures and guidelines.
      4) Complete operating instructions for all systems.
      5) Maintenance Instructions: Document all maintenance and repair/replacement procedures.
   b. Include the following documentation in the DDC Software Manual:
      1) Sequence of Operations
      2) Software Point Name Abbreviation List. Include Name, Description, Controller Where Located, Point Type and Point ID.
      3) I/O Point List. Include Point Name, Controller Location, Point Number, Control Device, Range and Span.
   c. Provide three copies of all manufacturers manuals covering the installed system.

2. Record Drawings

WARRANTY

A. Material:

1. The Control System shall be free from defects in material and workmanship under normal use and service. If within thirty six (36) months from the date of completion any of the equipment herein described is defective in operation, workmanship or materials, it will be replaced, repaired or adjusted at the option of the FMS Contractor free of charge.

B. Installation:

1. The Control System shall be free from defects in installation workmanship for a period of one year from acceptance. The FMS Contractor shall, free of charge, correct any defects in workmanship within one week of notification in writing by the Owner.
PART 2      PRODUCTS

NETWORK CONTROLLERS

A. Network Controller

1. The Network Controller shall be a fully user-programmable, supervisory controller. The Network Controller shall monitor the network of distributed application-specific controllers, provide global strategy and direction, and communicate on a peer-to-peer basis with other Network Controllers.

2. First Tier Network – The Network Controller (NC, NIE, or NAE) shall reside on the first tier network. Each NC shall support a sub-network of a minimum of 100 controllers on the second tier network.

3. Open Systems Port – Each controller shall have the ability to connect to third-party control systems by way of an Open Systems Port, as specified or as shown on the design drawings. All programming required to implement the OSP shall reside solely within the controller and the associated device.

4. Processor – Controllers shall be microprocessor-based with a minimum word size of 16 bits and a maximum program scan rate of 1 second. They shall be multi-tasking, multi-user, and real-time digital control processors. Controller size and capability shall be sufficient to fully meet the requirements of this Specification.

5. Memory – Each controller shall have sufficient memory to support its own operating system, databases, and control programs, and to provide supervisory control for all second tier controllers.

6. Hardware Real Time Clock – The controller shall have an integrated, hardware-based, real-time clock.

7. Communications Ports – The NC shall provide at least two RS-232 serial data communication ports for operation of operator I/O devices, such as industry-standard printers, operator terminals, modems, and portable operator’s terminals. Controllers shall allow temporary use of portable devices without interrupting the normal operation of permanently connected modems, printers, or terminals.

8. Diagnostics – Controller shall continuously perform self-diagnostics, communication diagnosis, and diagnosis of all panel components. The network controller shall provide both local and remote annunciation of any detected component failures, low battery conditions, or repeated failures to establish communication.
9. Power Failure – In the event of the loss of normal power, there shall be an orderly shutdown of all controllers to prevent the loss of database or operating system software. Nonvolatile memory shall be incorporated for all critical controller configuration data, and battery backup shall be provided to support the real-time clock and all volatile memory for a minimum of 72 hours.
   a. During a loss of normal power, the control sequences shall go to the normal system shutdown conditions.
   b. Upon restoration of normal power and after a minimum off-time delay, the controller shall automatically resume full operation without manual intervention through a normal soft-start sequence.
   c. Should a controller memory be lost for any reason, the operator workstation shall automatically reload the program without any intervention by the system operators.

10. Certification – All controllers shall be listed by Underwriters Laboratories (UL).

APPLICATION SPECIFIC CONTROLLERS

A. Air Handling Unit (AHU) Controllers

1. Each Air Handling Unit (AHU) controller shall operate as a standalone controller capable of performing its specified control responsibilities independently of other controllers in the network. Each AHU controller shall be a microprocessor-based, multi-tasking.

2. AHU controllers shall support, but not be limited to, the following configurations of systems to address current requirements as described in the “Execution” portion of this Specification, and to address future expansion:
   a. Air Handling Units:
      1) Mixed Air-Single Path
      2) Mixed Air-Dual Path
      3) 100% Single Path
      4) 100% Dual Path

3. Each AHU controller shall have sufficient memory to support its own operating system and databases, including:
   a. Control Processes
   b. Energy Management Applications
   c. Operator I/O (Portable Service Terminal)

4. Point types – Each AHU controller shall support the following types of point inputs and outputs:
   1) Analog inputs shall monitor the following analog signals:
   2) 4-20 mA Sensors
   3) 0-10 VDC Sensors
   4) 1000ohm RTDs
b. Binary inputs shall monitor dry contact closures. Input shall provide filtering to eliminate false signals resulting from input “bouncing.”

c. Counter inputs shall monitor dry contact pulses with an input resolution of one HZ minimum.

d. Analog outputs shall provide the following control outputs:
   1) 4.20 mA – Sink or Source
   2) 0-10 VDC

e. Binary outputs shall provide SPDT output contacts rated for 2 amps at 24 VAC. Surge and noise suppression shall be provided on all pilot relays. Inductive loads (i.e. solenoids) shall be controlled by pilot relays.
   1) TriState outputs shall be paired binary outputs for use as Power Close/Power Open control output contacts rated for 2 amps at 24 VAC. Surge and noise suppression shall be provided on all pilot relays.

5. AHU controllers shall have a library of control routines and program logic to perform the sequence of operations specified in the “Execution” portion of this Specification.

6. AHU controllers shall directly support the temporary use of a portable service terminal that can be connected to the AHU via zone temperature or directly at the controller.

7. Powerfail Protection – All system setpoints, proportional bands, control algorithms, and any other programmable parameters shall be stored such that a power failure of any duration does not necessitate reprogramming the AHU.

B. Expanded Digital Controller

1. Each controller shall operate as a standalone controller capable of performing its specified control responsibilities independently of other controllers in the network. Each controller shall be a microprocessor-based, multi-tasking, real-time digital control processor.

2. Controllers shall support, but not be limited to, the following configurations of systems to address current requirements described in the “Execution” portion of this Specification, and to address future expansion.
   a. Single boiler or chiller plants with pump logic.
   b. Cooling towers.
   c. Zone pressurization of labs.
   d. Generic system interlocking through hardware.

3. Point types – Each controller shall support the following types of point inputs and outputs:
   a. Analog inputs shall monitor the following analog signals:
      1) 4-20 mA Sensors
      2) 0-10 VDC Sensors
      3) 1000ohm RTDs
b. Binary inputs shall monitor dry contact closures. Input shall provide filtering to eliminate false signals resulting from input “bouncing.”

c. Counter inputs shall monitor dry contact pulses with an input resolution of one HZ minimum.

d. Analog outputs shall provide the following control outputs:
   1) 4.20 mA – Sink or Source
   2) 0-10 VDC

e. Binary outputs shall provide SPDT output contacts rated for 2 amps at 24 VAC. Surge and noise suppression shall be provided on all pilot relays. Inductive loads (i.e. solenoids) shall be controlled by pilot relays.

f. TriState outputs shall be paired binary outputs for use as Power Close/Power Open control output contacts rated for 2 amps at 24 VAC. Surge and noise suppression shall be provided on all pilot relays.

4. Controllers shall have a built-in status, and adjust panel interface to allow for the local adjustment of all setpoints, temporary override of any input or output points, and status of any points in alarm.

5. Powerfail Protection – All system setpoints, proportional bands, control algorithms, and any other programmable parameters shall be stored such that a power failure of any duration does not necessitate reprogramming the controller.

6. The capability to extend the input and output capacity of the controller via Point Expansion Modules shall be provided.
   a. The Point Expansion Modules shall communicate to the controller over a local RS-485 expansion bus.
   b. The Point Expansion Modules shall have available a range of configurations of 4, 8, 12, or 16 data points:
      1) Analog Inputs – 0-10V, 4-20mA, 1000 ohm RTD
      2) Analog Outputs – 0-10V, 4-20mA
      3) Digital Inputs w/ digital counter
      4) Digital Outputs – triacs or relay contacts
   c. Expansion module data points shall be available for inclusion in all DX-9100 control strategies.

C. Unitary Controllers (UNT)

1. Each Unitary Controller shall operate as a standalone controller capable of performing its specified control responsibilities independently of other controllers in the network. Each Unitary Controller shall be a microprocessor-based, multi-tasking.

2. Unitary Controllers shall support, but not be limited to, the following types of systems to address specific applications described in the “Execution” portion of this Specification, and to address future expansion:
   Fan Coils (Two-Pipe, Four-Pipe).
3. Point types – Each Unitary Controller shall support the following types of point inputs and outputs:
   a. Analog inputs shall monitor the following analog signals:
      1) 0-10 VDC Sensors
      2) 1000ohm RTDs
   b. Binary inputs shall monitor dry contact closures. Input shall provide filtering to eliminate false signals resulting from input “bouncing.”
   c. Counter inputs shall monitor dry contact pulses with an input resolution of one HZ minimum.
   d. Analog outputs shall provide the following control outputs:
      1) 0-10 VDC
   e. Binary outputs shall provide SPDT output contacts rated for 2 amps at 24 VAC. Surge and noise suppression shall be provided on all pilot relays. Inductive loads (i.e. solenoids) shall be controlled by pilot relays.
   f. TriState outputs shall be paired binary outputs for use as Power Close/Power Open control output contacts rated for 2 amps at 24 VAC. Surge and noise suppression shall be provided on all pilot relays.

4. Unitary Controllers shall have a library of control routines and program logic to perform the sequence of operations specified in the “Execution” portion of this Specification.

5. Unitary Controllers shall directly support the temporary use of a portable service terminal that can be connected to the UNT via zone temperature or directly at the controller.

6. Powerfail Protection – All system setpoints, proportional bands, control algorithms, and any other programmable parameters shall be stored such that a power failure of any duration does not necessitate reprogramming the UNT.

D. VAV Terminal Unit Controller (VAV)

1. VAV controllers are to be factory mounted. Costs associated with mounting of controllers are the responsibility of the VAV box manufacturer.

2. The VAV shall provide both standalone and networked direct digital control of pressure-independent, variable air volume terminal units.

3. The VAV shall be a configurable digital controller with integral differential pressure transducer and damper actuator. All components shall be connected and mounted as a single assembly that can be removed as one piece.

4. The integral damper actuator shall be a fast response stepper motor capable of stroking 90 degrees in 30 seconds for quick damper positioning to speed commissioning and troubleshooting tasks.
5. The VAV shall determine airflow by dynamic pressure measurement using an integral dead-ended differential pressure transducer. The transducer shall be maintenance-free and shall not require air filters.

6. Each VAV shall have the ability to automatically calibrate the flow sensor to eliminate pressure transducer offset error due to ambient temperature / humidity effects.

7. The VAV shall utilize a proportional plus integration (PI) algorithm for the space temperature control loops.

8. Each VAV shall continuously, adaptively tune the control algorithms to improve control and controller reliability through reduced actuator duty cycle. In addition, this tuning reduces commissioning costs, and eliminates the maintenance costs of manually re-tuning loops to compensate for seasonal or other load changes.

9. The VAV shall provide the ability to download and upload VAV configuration files, both locally and via the communications network. Controllers shall be able to be loaded individually or as a group using a zone schedule generated spreadsheet of controller parameters.

10. VAV control setpoint changes initiated over the network shall be written to VAV non-volatile memory to prevent loss of setpoint changes and to provide consistent operation in the event of communication failure.

11. The VAV firmware shall be flash-upgradeable remotely via the communications bus to minimize costs of feature enhancements.

12. The VAV shall provide fail-soft operation if the airflow signal becomes unreliable, by automatically reverting to a pressure-dependent control mode.

13. The VAV shall interface with balancer tools that allow automatic recalculation of box flow pickup gain ("K" factor), and the ability to directly command the airflow control loop to the box minimum and maximum airflow setpoints.

14. The VAV shall be capable of direct electronic connection to the Alnor DB150 Balometer balancing hood. Connection shall be through a port located on the room sensor, or directly at the controller. As an alternative, software balancing tools shall be provided that will run in a hand-held Palm Pilot type PC (such as the 3COM Palm Pilot or IBM Workpad). The balancing tools shall allow adjustment of airflow setpoints and parameters, and provide permanent upload of the values entered to the VAV. The Palm Pilot shall connect to the terminal unit through the room sensor port.
15. The VAV performance shall be self-documenting via on-board diagnostics. These diagnostics shall consist of control loop performance measurements executing at each control loop’s sample interval, which may be used to continuously monitor and document system performance. The VAV shall calculate exponentially weighted moving averages (EWMA) for each of the following. These metrics shall be available to the end user for efficient management of the VAV terminals.
   a. Absolute temperature loop error.
   b. Signed temperature loop error.
   c. Absolute airflow loop error.
   d. Signed airflow loop error.
   e. Average damper actuator duty cycle.

16. The VAV shall detect system error conditions to assist in managing the VAV zones. The error conditions shall consist of:
   a. Unreliable space temperature sensor.
   b. Unreliable differential pressure sensor.
   c. Starved box.
   d. Insufficient cooling.
   e. Insufficient heating.

17. The VAV shall provide a compliant interface for ASHRAE Standard 62-1989 (indoor air quality), and shall be capable of resetting the box minimum airflow based on the percent of outdoor air in the primary air stream.

18. The VAV shall comply with ASHRAE Standard 90.1 (energy efficiency) by preventing simultaneous heating and cooling, and where the control strategy requires reset of airflow while in reheat, by modulating the box reheat device fully open prior to increasing the airflow in the heating sequence.

19. The VAV shall be compatible with the U.S. EPA Energy Star Buildings recommendations for fan energy reduction via demand-based static pressure reset down to 2/3 of duct static pressure set point, “VSD 2/3 Reset.”

20 Inputs:
   a. Analog inputs shall monitor the following analog signals, without the addition of equipment outside the terminal controller cabinet:
      1) 0-10 VDC Sensors
      2) 1000ohm RTDs
      3) NTC Thermistors
   b. Binary inputs shall monitor dry contact closures. Input shall provide filtering to eliminate false signals resulting from input “bouncing.”
   c. For noise immunity, the inputs shall be internally isolated from power, communications, and output circuits.
21. Outputs
   a. Analog outputs shall provide the following control outputs:
      1) 0-10 VDC
   b. Binary outputs shall provide a SPST Triac output rated for
      500mA at 24 VAC.
   c. For noise immunity, the outputs shall be internally isolated from
      power, communications, and other output circuits.

22. VAV controllers located on boxes with reheat shall have discharge air
    temperature sensors.

E. Building Chilled Water Supply Isolation
   1. A modulating valve shall be installed in the Chilled Water Supply pipe
      between the tunnel and the building pumps at ASU at the Tempe
      campus. This valve shall be controlled by an operator selectable
      pump suction pressure control setpoint

INPUT DEVICES

A. General Requirements
   1. Installation, testing, and calibration of all sensors, transmitters, and
      other input devices shall be provided to meet the system
      requirements.

B. Temperature Sensors
   1. General Requirements:
      a. Sensors and transmitters shall be provided, as outlined in the
      input/output summary and sequence of operations.
      b. The temperature sensor shall be of the resistance type, and
      shall be either two-wire 1000 ohm nickel RTD, or two-wire 1000
      ohm platinum RTD. Thermistors are not an acceptable
      alternate.
      c. The following point types (and the accuracy of each) are
      required, and their associated accuracy values include errors
      associated with the sensor, lead wire, and A to D conversion:

      | Point Type       | Accuracy |
      |------------------|----------|
      | Chilled Water    | ± .5°F.  |
      | Room Temp        | ± .5°F.  |
      | Duct Temperature | ± .5°F.  |
      | All Others       | ± .75°F. |
2. Room Temperature Sensors
   a. Room sensors shall be constructed for either surface or wallbox mounting.
   b. Room sensors shall have the following options when specified:
      1) Setpoint reset slide switch providing a ±3 degree (adjustable) range.
      2) Individual heating/cooling setpoint slide switches.
      3) A momentary override request push button for activation of after-hours operation.
      4) Analog thermometer.

3. Thermowells
   a. When thermowells are required, the sensor and well shall be supplied as a complete assembly, including well head and Greenfield fitting.
   b. Thermowells shall be pressure rated and constructed in accordance with the system working pressure.
   c. Thermowells and sensors shall be mounted in a threadolet or 1/2” NFT saddle and allow easy access to the sensor for repair or replacement.

4. Outside Air Sensors
   a. Outside air sensors shall be designed to withstand the environmental conditions to which they will be exposed. They shall also be provided with a solar shield.
   b. Sensors exposed to wind velocity pressures shall be shielded by a perforated plate that surrounds the sensor element.
   c. Temperature transmitters shall be of NEMA 3R construction and rated for ambient temperatures.

5. Duct Mount Sensors
   a. Duct mount sensors shall mount in an electrical box through a hole in the duct, and be positioned so as to be easily accessible for repair or replacement.
   b. Duct sensors shall be insertion type and constructed as a complete assembly, including lock nut and mounting plate.
   c. For outdoor air duct applications, a weatherproof mounting box with weatherproof cover and gasket shall be used.

6. Averaging Sensors
   a. For ductwork greater in any dimension that 48 inches and/or where air temperature stratification exists, an averaging sensor with multiple sensing points shall be used.
   b. For plenum applications, such as mixed air temperature measurements, a string of sensors mounted across the plenum shall be used to account for stratification and/or air turbulence. The averaging string shall have a minimum of 4 sensing points per 12-foot long segment.
   c. Capillary supports at the sides of the duct shall be provided to support the sensing string.

C. Humidity Sensors
1. The sensor shall be a solid state type, relative humidity sensor of the Bulk Polymer Design. The sensor element shall resist service contamination.

2. The humidity transmitter shall be equipped with non-interactive span and zero adjustments, a 2-wire isolated loop powered, 4-20 mA, 0-100% linear proportional output.

3. The humidity transmitter shall meet the following overall accuracy, including lead loss and Analog to Digital conversion. [more information]

4. Outside air relative humidity sensors shall be installed with a rain proof, perforated cover. The transmitter shall be installed in a NEMA 3R enclosure with sealite fittings and stainless steel bushings.

5. A single point humidity calibrator shall be provided, if required, for field calibration. Transmitters shall be shipped factory pre-calibrated.

6. Duct type sensing probes shall be constructed of 304 stainless steel, and shall be equipped with a neoprene grommet, bushings, and a mounting bracket.

D. Pressure Transmitters

1. General Air and Water Pressure Transmitter Requirements:
   a. Pressure transmitters shall be constructed to withstand 100% pressure over-range without damage, and to hold calibrated accuracy when subject to a momentary 40% over-range input.
   b. Pressure transmitters shall transmit a 0 to 5 VDC, 0 to 10 VDC, or 4 to 20 mA output signal.
   c. A minimum of a NEMA 1 housing shall be provided for the transmitter. Transmitters shall be located in accessible local control panels wherever possible.
   d. Pressure sensors in hydronic systems must be rated for # 3000 psi or greater and 1000 psi differential pressure or greater.

E. Flow Monitoring

1. Air Flow Monitoring
   a. Duct Air Flow Measuring Stations
      1) Each device shall be designed and built to comply with, and provide results in accordance with, accepted practice as defined for system testing in the ASHRAE Handbook of fundamentals, as well as in the Industrial Ventilation Handbook.
      2) Airflow measuring stations shall be fabricated of 14-gauge galvanized steel welded casing with 90 Deg. connecting flanges in configuration and size equal to that of the duct into which it is mounted. Each station shall be complete with an air directionalizer and parallel cell profile suppressor (3/4” maximum cell) across the entering air stream and mechanically fastened to the casing in such a
way to withstand velocities up to 6000 feet per minute. This air directioneralizer and parallel cell honeycomb suppressor shall provide 98% free area, equalize the velocity profile, and eliminate turbulent and rotational flow from the air stream prior to the measuring point.

3) The total pressure measurement side (high side) will be designed and spaced to the Industrial Ventilation Manual 16th Edition, Page 9-5. The self-averaging manifolding will be manufactured of brass and copper components.


5) The main take-off point from both the total pressure and the static pressure manifolds must be symmetrical.

6) Total and static pressure manifolds shall terminate with external ports for connection to control tubing. An identification label shall be placed on each unit casing, listing model number, size, area, and specified airflow capacity.

7) Installation Considerations

   a. Static Pressure Traverse Probe

      1) Duct static traverse probes shall be provided where required to monitor duct static pressure. The probe shall contain multiple static pressure sensors located along exterior surface of the cylindrical probe.
2. Water Flow Monitoring
   a. Flow sensor range shall be from zero (0) flow to one hundred and fifty (150) percent of the maximum rated flow for each application and be of industrial grade. Minimum accuracy at full scale shall be +/- 1 percent of full scale.
   b. All water flow sensors shall be installed in a manner which permits retraction and replacement of the sensor for service without interrupting or affecting the application being monitored (hot taps).
   c. Liquid flow sensors that are not used for BTU monitoring, shall be Onicon insertion-type turbine flow sensors (or ASU/BAS approved equal) installed as hot tap. Install in strict conformance with manufacturer’s recommendations.

F. Campus Energy Information System- EIS
   1. General requirements
      a. The BAS contractor shall be responsible for the complete installation of all system components, connections and configuration.
      b. Electrical usage shall be monitored using a VERIS H8036 KW meter.
      c. Chilled water shall be monitored using a Controlatron BTU meter. New installations shall require thermo wells for temperature sensors. Existing installations may use strap-on sensors.
      d. Steam usage – Total steam usage must be metered. If applicable a Controlatron BTU meter can be used for Heating Hot water. If heating hot water is not representative of the total steam load, then Rosemount steam flow, temperature, and pressure instruments shall be installed.
      e. EIS field controllers shall be an Emerson ROC 809. Communication to metering devices shall be by modbus protocol when applicable. Analog outputs shall be provided to output systems flow, temperature and pressure values to the JCI Metasys BAS.
      f. EIS field controllers shall be connected to the campus EIS fiber network.
      g. The BAS contractor shall be responsible for the complete Fiber installation to the nearest campus building Switch or Hub.
      h. Configuration shall include mapping points to the EIS workstation.
i. Condensate Return temperature must be monitored by the EIS.

G. Status and Safety Switches

1. General Requirements
   a. Switches shall be provided to monitor equipment status, safety conditions, and generate alarms at the FMS when a failure or abnormal condition occurs. Safety switches shall be provided with two sets of contacts and shall be interlock wired to shut down respective equipment.

2. Current Sensing Switches
   a. The current sensing switch shall be self-powered with solid-state circuitry and a dry contact output. It shall consist of a current transformer, a solid state current sensing circuit, adjustable trip point, solid state switch, SPDT relay, and an LED indicating the on or off status. A conductor of the load shall be passed through the window of the device. It shall accept over-current up to twice its trip point range.
   b. Current sensing switches shall be used for run status for fans, pumps, and other miscellaneous motor loads.
   c. Current sensing switches shall be calibrated to show a positive run status only when the motor is operating under load. A motor running with a broken belt or coupling shall indicate a negative run status.

3. Air Flow Switches
   a. Differential pressure flow switches shall be bellows actuated mercury switches or snap acting micro-switches with appropriate scale range and differential adjustment for intended service.

4. Air Pressure Safety Switches
   a. Air pressure safety switches shall be of the manual reset type with SPDT contacts rated for 2 amps at 120VAC.
   b. Pressure range shall be adjustable with appropriate scale range and differential adjustment for intended service.

5. Water Flow Switches
   a. Water flow switches shall be equal to the Johnson Controls P74.

6. Low Temperature Limit Switches
   a. The low temperature limit switch shall be of the manual reset type with Double Pole/Single Throw snap acting contacts rated for 16 amps at 120VAC.
   b. The sensing element shall be a minimum of 15 feet in length and shall react to the coldest 18-inch section. Element shall be mounted horizontally across duct in accordance with manufacturers recommended installation procedures.
c. For large duct areas where the sensing element does not provide full coverage of the air stream, additional switches shall be provided as required to provide full protection of the air stream.

OUTPUT DEVICES

A. Actuators

1. General Requirements
   a. Damper and valve actuators shall be electronic.

2. Electronic Damper Actuators
   a. Electronic damper actuators shall be direct shaft mount.
   b. Modulating and two-position actuators shall be provided as required by the sequence of operations. Damper sections shall be sized based on actuator manufacturer’s recommendations for face velocity, differential pressure and damper type. The actuator mounting arrangement and spring return feature shall permit normally open or normally closed positions of the dampers, as required. All actuators (except terminal units) shall be furnished with mechanical spring return unless otherwise specified in the sequences of operations. All actuators shall have external adjustable stops to limit the travel in either direction, and a gear release to allow manual positioning.
   c. Modulating actuators shall accept 24 VAC or VDC power supply, consume no more than 15 VA, and be UL listed. The control signal shall be 2-10 VDC or 4-20 mA, and the actuator shall provide a clamp position feedback signal of 2-10 VDC. The feedback signal shall be independent of the input signal and may be used to parallel other actuators and provide true position indication. The feedback signal of one damper actuator for each separately controlled damper shall be wired back to a terminal strip in the control panel for trouble-shooting purposes.
   d. Two-position or open/closed actuators shall accept 24 or 120 VAC power supply and be UL listed. Isolation, smoke, exhaust fan, and other dampers, as specified in the sequence of operations, shall be furnished with adjustable end switches to indicate open/closed position or be hard wired to start/stop associated fan. Two-position actuators, as specified in sequences of operations as “quick acting,” shall move full stroke within 20 seconds. All smoke damper actuators shall be quick acting.

3. Electronic Valve Actuators
   a. Electronic valve actuators shall be manufactured by Belimo.
   b. Each actuator shall have current limiting circuitry incorporated in its design to prevent damage to the actuator.
   c. Modulating and two-position actuators shall be provided as required by the sequence of operations. Actuators shall provide the minimum torque required for proper valve close-off against...
the system pressure for the required application. The valve actuator shall be sized based on valve manufacturer's recommendations for flow and pressure differential. All actuators shall fail in the last position unless specified with mechanical spring return in the sequence of operations. The spring return feature shall permit normally open or normally closed positions of the valves, as required. All direct shaft mount rotational actuators shall have external adjustable stops to limit the travel in either direction.

d. Modulating Actuators shall accept 24 VAC or VDC and 120 VAC power supply and be UL listed. The control signal shall be 2-10 VDC or 4-20 mA and the actuator shall provide a clamp position feedback signal of 2-10 VDC. The feedback signal shall be independent of the input signal, and may be used to parallel other actuators and provide true position indication. The feedback signal of each valve actuator (except terminal valves) shall be wired back to a terminal strip in the control panel for trouble-shooting purposes.

e. Two-position or open/closed actuators shall accept 24 or 120 VAC power supply and be UL listed. Butterfly isolation and other valves, as specified in the sequence of operations, shall be furnished with adjustable end switches to indicate open/closed position or be hard wired to start/stop the associated pump or chiller.

B. Control Dampers

1. All dampers used for throttling airflow shall be of the opposed blade type arranged for normally open or normally closed operation, as required. The damper is to be sized so that, when wide open, the pressure drop is a sufficient amount of its close-off pressure drop to shift the characteristic curve to near linear.

2. All dampers used for two-position, open/close control shall be parallel blade type arranged for normally open or closed operation, as required.

3. Damper frames and blades shall be constructed of either galvanized steel or aluminum. Maximum blade length in any section shall be 48”. Damper blades shall be 16-gauge minimum and shall not exceed six (6) inches in width. Damper frames shall be 16-gauge minimum hat channel type with corner bracing. Additional stiffening or bracing shall be provided for any section exceeding 48” in height. All damper bearings shall be made of stainless steel or oil-impregnated bronze. Dampers shall be tight closing, low leakage type, with synthetic elastomer seals on the blade edges and flexible stainless steel side seals. Dampers of 48”x48” size shall not leak in excess of 8.5 cfm per square foot when closed against 4” w.g. static pressure when tested in accordance with AMCA Std. 500.

4. Air foil blade dampers of double skin construction with linkage out of the air stream shall be used whenever the damper face velocity
exceeds 1500 FPM or system pressure exceeds 2.5” w.g., but no more than 4000 FPM or 6” w.g. Acceptable manufacturers are Johnson Controls D-1300, Ruskin CD50, and Vent Products 5650.

5. One piece rolled blade dampers with exposed or concealed linkage may be used with face velocities of 1500 FPM or below.

6. Multiple section dampers may be jack-shafted to allow mounting of piston pneumatic actuators and direct connect electronic actuators. Each end of the jack shaft shall receive at least one actuator to reduce jack shaft twist.

C. Control Relays

1. Control Pilot Relays
   a. DPDT, 3PDT, or 4PDT relays shall be provided, as appropriate for application.
   b. Contacts shall be rated for 10 amps at 120VAC.
   c. Relays shall have an integral indicator light.

D. Control Valves

1. All automatic control valves shall be fully proportioning and provide near linear heat transfer control. The valves shall be quiet in operation and fail-safe open, closed, or in their last position. All valves shall operate in sequence with another valve when required by the sequence of operations. All control valves shall be sized by the control manufacturer, and shall be guaranteed to meet the heating and cooling loads, as specified. All control valves shall be suitable for the system flow conditions and close against the differential pressures involved.

2. Chilled water control valves shall be modulating plug, ball, and/or butterfly, as required by the specific application. Modulating water valves shall be sized per manufacturer’s recommendations for the given application. In general, valves pressure drop at design flow through control valves shall be no more than 3 PSI. Valves (3-way) serving constant flow air handling unit coils with secondary circuit pumps shall be sized for a pressure drop equal to 25% the actual coil pressure drop, but no less than 2 PSI. Mixing valves (3-way) serving secondary water circuits shall be sized for a pressure drop of no less than 3 PSI. Valves for terminal reheat coils shall be sized for a 2 PSIG pressure drop, but no more than a 3 PSI drop.

3. Modulating plug water valves of the single-seat type with equal percentage flow characteristics shall be used for all hot and chilled water applications, except those described hereinafter. The valve discs shall be composition type. Valve stems shall be stainless steel.

4. Delta or Belimo Ball valves, with stainless steel ball and stem, shall be acceptable for water terminal reheat coils, radiant panels, unit heaters, air handler units, package air conditioning units, and fan coil units.
5. Butterfly valves shall be acceptable for modulating large flow applications greater than modulating plug valves, and for all two-position, open/close applications. In-line and/or three-way butterfly valves shall be heavy-duty pattern with a body rating comparable to the pipe rating, replaceable lining suitable for temperature of system. Valves for modulating service shall be sized and travel limited to 50 degrees of full open. Valves for isolation service shall be the same as the pipe. Valves in the closed position shall be bubble-tight.

Graphics:

A. The graphics shall be able to display and provide animation based on real-time data that is acquired, calculated, or entered.

B. Multiple graphic applications shall be able to execute at any one time on a single workstation.

C. The operator shall be able to configure the speed at which data will be updated on the specific graphic.

D. Basic graphical objects – All graphics shall be able to be constructed from the following basic graphical objects:

1. Single or multi-segment lines of any thickness – line styles at a minimum shall include: solid, dotted, and dashed.

2. Rectangles, Polygons, Arcs, Circles, and Ellipses – User may fill with any color or no fill, and may configure the thickness of the outline.

3. Text Boxes – User may configure text boxes with any W98 True Type font, any foreground color, any background color, and with 8 or more thickness levels.

E. Animation: Any basic object, any group of basic objects, or any symbol or group of symbols, shall be capable of being animated in the following manner:

1. Color Change – up to 32 different color states.

2. Size – Any object’s size shall be able to be animated based on the value of an analog variable.

3. Movement – Any object can be animated to move either in a straight line, or can follow a configured path of any number of line segments.

4. Rotation – Any object shall be able to be animated up 360 degrees.

5. Visibility – It shall be possible to make any object dynamically appear or disappear based on the true/false result of any boolean equations.

F. Operation from Graphics – It shall be possible to change values (setpoints) and states in system controlled equipment by any of the following methods of operator interaction:
1. By selecting the object with either the left, middle, or right mouse button:
   a. Load a specific graphic.
   b. Drag / Drop to load a graphic in a selected window.
   c. Link forward or backward to another graphic.
   d. Change or toggle the value of an object.
   e. Launch an executable application.

2. Slider action – Any object can be defined to be a slider and configured to change a setpoint or other variables as the user slides an object over a configured geometry.

3. Dial Action – Any object can be configured so that it can change a configured analog value over a range as the object is rotated. This is most often used to represent dials.

4. Data Entry – A variable is displayed on a graphic. By selecting the variable, the data entry function for the value is enabled and the operator is able to enter a new value for the variable.

G. Graphic Editing Tool: A graphic editing tool shall be provided that allows for the creating and editing of graphic files. The graphic editor shall be capable of performing all drawing functions, defining all calculations to be executed as part of the graphic, defining all animations, and defining all runtime binding. It is not acceptable for separate programs to be required to do these various functions.

1. The graphic editing tool shall in general provide for the creation and positioning of objects by dragging from tool bars and positioning where required. It shall provide the ability to create, at a minimum, all of the object types, all of the animation algorithms, and all of the action types referenced in this section.

2. In addition, the graphic editing tool shall be able to add additional content to any graphic by importing any Windows metafile (.wmf) or any bitmap file (.bmp).

H. Symbol library – The FMS system shall be provided with a very complete symbol library containing all of the basic symbols used to represent HVAC, Fire, and Security components of a typical FMS system:

1. Symbols shall be able to be added to any graphic display being constructed by simply dragging the symbol from the library to the graphic under construction.

2. Creating Symbols- The user shall be able to add any number of new symbols to the symbol library. Symbol generation shall include all of the abilities described for the graphic editor.

3. Any drawing – including all objects contained therein, and all animation definitions, and all action definitions – shall be able to be grouped and saved into the symbol library for re-use in graphic displays. Symbols shall be able to include implicit bindings or aliased bindings, as described in the following sections.
I. Many graphic displays representing part of a building and various building components are exact duplicates, with the exception that the various variables are bound to different field values. Consequently, it shall be possible to bind the value of a graphic display to aliases, as opposed to the physical field tags. The same graphic display can then be used an unlimited number of times by simply providing a look-up table for the aliases that correspond to each individual use of the graphic.

J. Graphical displays shall include room, zone, and sensor/thermostat locations.

PART 3 PERFORMANCE/ EXECUTION

INSTALLATION PRACTICES

A. HVAC Control System Wiring

1. All low voltage (under 120 volt) conduit, wiring, accessories and wiring connections required for the installation of the Facility Management System, as herein specified, shall be provided by the FMS Contractor unless specifically shown on the Electrical Drawings under Division 26 Electrical. All wiring shall comply with the requirements of applicable portions of Division 26 and all local and national electric codes, unless specified otherwise in this section.

2. All system input wiring shall be twisted shielded pair, minimum 18 gauge wire. All system analog output wiring shall be twisted shielded pair/3-wire as required, minimum 18 gauge wire. Preconfigured cables between Terminal Unit Controllers and Thermostats are acceptable, minimum 24 gauge.

3. All Class 2 (24VAC or less) wiring in concealed areas or in mechanical rooms shall be installed in conduit.

4. Exposed wiring shall only be allowed in concealed accessible locations.
   a. Class 2 wiring not installed in conduit shall be supported every 5' from the building structure utilizing metal hangers designed for this application. Wiring shall be installed parallel to the building structural lines. All wiring shall be installed in accordance with local code requirements.

5. All wiring in mechanical rooms shall be in conduit.

B. DDC System Multi-conductor Instrumentation and Communication Cabling Standards:

1. Analog input, Analog Output, Binary Input, Binary Output, 24 VAC and General Purpose Cabling
   a. Cable shall consist of copper conductors not less than No. 18 AWG-stranded.
   b. Shall be 2 or 3 conductor twisted cable with a drain wire.
c. Cable shall have a 100% overall shield.
d. Cable shall be plenum-rated.
e. Cable shall meet or exceed NEC voltage rating of 300V.
f. Cable shall be NEC type CMP.
g. Cable shall meet or exceed UL temperature rating of +60 degrees C.
h. Cable shall be labeled at a minimum of every 18" with the DDC system manufacturer’s name and the type of signal carried within the cable, i.e. Analog Input, Analog Output, Binary Input, Binary Output, 24 VAC.
i. Each of the cable types specified in the Item A shall be of a different color coding for easy identification and troubleshooting. Recommended color coding:

1) Analog Input Cable Yellow
2) Analog Output Cable Tan
3) Binary Input Cable Orange
4) Binary Output Cable Violet
5) 24 VAC cable Gray
6) General Purpose Cable Natural

2. Primary and Secondary Communications Network Cabling
a. Cable shall be of type recommended by the DDC system manufacturer.
b. Cable shall be shielded.
c. Cable shall be plenum-rated.
d. Cable shall meet or exceed NEC voltage rating of 150V.
e. Cable shall meet or exceed UL temperature rating of +60 degrees C.
f. Cable shall be labeled at a minimum of every 18" with the DDC system manufacturer’s name, system name and the communications network name.
g. Each of the cable types shall be of a different color-coding for easy identification and troubleshooting and shall be of a different color than the cable specified in Item A above.

3. Room Sensor Cabling
a. Cable shall consist of copper conductors not less No. 24 AWG.
b. Shall be mult-paired (at least two pairs) twisted cable.
c. Cable shall have a 100% overall shield.
d. Cable shall be plenum-rated.
e. Cable shall meet or exceed NEC voltage rating of 300V.
f. Cable shall be NEC type Article 800-CMP.
g. Cable shall meet or exceed UL temperature rating of +75 degrees C.
h. Cable shall be labeled at a minimum of every 18" with the DDC system manufacturer’s name and labeled as a stat cable.

C. Wire Labels/ Device Tagging:
1. Controller Identification. All controllers shall be identified by a nameplate securely fastened to the outside of the controller enclosure.

2. Panel Identification. All local control panels shall be identified by a nameplate securely fastened to the outside of the controller enclosure.

3. Field Devices. All field devices shall be identified by a typed (not handwritten) securely attached tag label. Each tag will consist of a stainless steel wire and stainless steel tag. The device name will match the object name on the control drawings. One tag will be provided for every valve, sensor, etc.

4. Panel Devices. All panel devices shall be identified by a typed label. Each tag shall consist of a black plastic tag with white lettering. Device names will match object on control drawings. One tag will be provided for every panel mounted device (transformers, controllers, etc.) Tags will be securely fixed to panel device with sticky back tape.

5. Wire Identification. All low and line voltage control wiring shall be identified as referenced to the associated control diagram, at each end of the conductor or cable. Identification shall be permanently secured to the conductor or cable and shall be typed.

D. Digital Controller Systems

1. Each system will be provided with its own dedicated direct digital controller or application specific controller. Mechanical systems such as AHUs, VAVs or Packaged system shall not be controlled from more than 1 application specific controller.

2. Systems that use second tier controllers as point expansion for system controllers shall only be allowed under when the I/O points are directly controlled by the CPU of the local application specific controller.

TRAINING

A. The contractor shall provide the following training.

1. The control contractor shall provide 4 hours of on-site orientation by a field engineer whom are fully knowledgeable of the specific installation details of the project. This orientation shall, at a minimum, consist of a review of the project as-built drawings, the control system software layout and naming conventions, and a walk through of the facility to identify panel and device locations.
COMMISSIONING

A. Commissioning the Facility Management System is a mandatory documented performance requirement of the selected FMS Contractor for all control systems detailed in this Specification and sequence of operations. Commissioning shall include verification of proper installation practices by the FMS Contractor and subcontractors under the FMS Contractor, point verification and calibration, system/sequence of operation verification with respect to specified operation, and network/workstation verification. Documentation shall be presented upon completion of each commissioning step and final completion to ensure proper operation of the Facility Management System.

1. Commissioning documents will be provided to ASU Building Automation Systems Services upon completion.

B. Testing Procedure

1. Upon completion of the installation, the FMS Contractor shall start-up the system and perform all necessary testing and run diagnostic tests to ensure proper operation. The FMS Contractor shall be responsible for generating all software and entering all database information necessary to perform the sequences of control herein specified.

C. Field Points Testing

1. This step shall verify that all of the installed points receive or transmit the correct information prior to loading/activating the system software.

2. ON/OFF commands from the workstation shall be performed in order to verify each binary output point.

3. All binary input points are to be tested using the HAND/OFF/AUTOMATIC selector switch on the associated motor control center or by manually jumpering across the field device contacts.

4. All analog output points shall be tested using a command from the workstation to modulate the output device from minimum calibrated signal to maximum calibrated output.

5. All analog input points are to be tested by comparing the reading obtained through the workstations or portable terminal to the value of an independent testing meter.

D. Noncompliant Items:

1. The Contractor shall remove and replace, at its expense, all items that are not in compliance with the Specification requirements.
SEQUENCES

A. Sequences of operations shall be project specific, comply with ASU standards, and must be approved by ASU Building Automation System Services.

SCOPE OF WORK

T = Temperature Control Contractor  
M = Mechanical Contractor  
E = Electrical Contractor  
O = Other

<table>
<thead>
<tr>
<th>System Description</th>
<th>Supplied By</th>
<th>Mounted By</th>
<th>Wired/Piped By</th>
</tr>
</thead>
<tbody>
<tr>
<td>STEAM/HOT WATER</td>
<td></td>
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<tr>
<td>Manufacture supplied controls</td>
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<td>T</td>
<td>T</td>
</tr>
<tr>
<td>Manufacture interlocks</td>
<td>-</td>
<td>-</td>
<td>M</td>
</tr>
<tr>
<td>Thermowell</td>
<td>T</td>
<td>M</td>
<td>-</td>
</tr>
<tr>
<td>Steam/HW control valve(s)</td>
<td>T</td>
<td>M</td>
<td>T</td>
</tr>
<tr>
<td>Temperature sensor</td>
<td>T</td>
<td>T</td>
<td>T</td>
</tr>
<tr>
<td>Pressure transmitter</td>
<td>T</td>
<td>M</td>
<td>T</td>
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<tr>
<td>GPM Flow meter/transmitter</td>
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<td>M</td>
<td>T</td>
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<tr>
<td>Pump differential pressure switch</td>
<td>T</td>
<td>M</td>
<td>T</td>
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<tr>
<td>Pump control relay/current sensor</td>
<td>T</td>
<td>T</td>
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<tr>
<td>Variable Frequency Drive (Power)</td>
<td>O</td>
<td>O</td>
<td>E</td>
</tr>
<tr>
<td>Variable Frequency Drive (Control)</td>
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<td>-</td>
<td>T</td>
</tr>
<tr>
<td>Combustion Air Damper</td>
<td>T</td>
<td>M</td>
<td>T</td>
</tr>
</tbody>
</table>

| CHILLED WATER                                     |             |            |                |
| Manufacture supplied controls                     | O           | T          | T              |
| Manufacture interlocks                            | -           | -          | M              |
| Thermowell                                        | T           | M          | -              |
| CHW control valve(s)                              | T           | M          | T              |
| Temperature sensor                                | T           | T          | T              |
| Pressure transmitter                              | T           | M          | T              |
| GPM Flow meter/transmitter                        | T           | M          | T              |
| Pump differential pressure switch                 | T           | M          | T              |
| Pump control relay/current sensor                 | T           | T          | T              |
| Variable Frequency Drive (Power)                  | O           | O          | E              |

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<table>
<thead>
<tr>
<th>Variable Frequency Drive (Control)</th>
<th>-</th>
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<tr>
<td>Refrigerant monitoring system</td>
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<tr>
<td>Pump Suction Pressure Sensor</td>
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### AIR HANDLING UNIT

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<td>Manufacture interlocks</td>
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<td>M</td>
</tr>
<tr>
<td>Control damper(s)</td>
<td>O</td>
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<td>M</td>
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<tr>
<td>Control damper actuator(s)</td>
<td>T</td>
<td>T</td>
<td>T</td>
</tr>
<tr>
<td>Steam/HW/CHW control valve(s)</td>
<td>T</td>
<td>M</td>
<td>T</td>
</tr>
<tr>
<td>Temperature/humidity sensor(s)</td>
<td>T</td>
<td>T</td>
<td>T</td>
</tr>
<tr>
<td>Pressure transmitter</td>
<td>T</td>
<td>T</td>
<td>T</td>
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<tr>
<td>CFM Flow meter/transmitter</td>
<td>T</td>
<td>M</td>
<td>T</td>
</tr>
<tr>
<td>Differential pressure switch</td>
<td>T</td>
<td>T</td>
<td>T</td>
</tr>
<tr>
<td>Control relay/current sensor</td>
<td>T</td>
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<table>
<thead>
<tr>
<th>Variable Frequency Drive (Power)</th>
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<tbody>
<tr>
<td>Variable Frequency Drive (Control)</td>
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</table>

### AHU SAFETIES

| Temperature low limit | T | T | T |
| Humidity high limit | T | T | T |
| Static pressure switch | T | T | T |
| Duct smoke detector fan interlock | O | O | E |
| Duct smoke detector to fire alarm system | E | E | E |

### VAV BOX

<table>
<thead>
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<th>VAV box controls</th>
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<tr>
<td>Space temperature sensor</td>
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<tr>
<td>Hot water reheat control valve</td>
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<td>M</td>
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</tbody>
</table>

### UNITVENTILATOR

| Unitventilator controls | T | O | O |
| Control damper(s) | O | M | T |
| Control damper actuator(s) | T | T | T |
| Steam/HW/CHW control valve(s) | T | M | T |
| Temperature/humidity sensor(s) | T | T | T |
| Differential pressure switch | T | T | T |
| Control relay/current sensor | T | T | T |

### FAN COIL UNIT

<p>| Control damper(s) | O | M | T |
| Control damper actuator(s) | T | T | T |
| Steam/HW/CHW control valve(s) | T | M | T |
| Temperature/humidity sensor(s) | T | T | T |
| Differential pressure switch | T | T | T |
| Control relay/current sensor | T | T | T |</p>
<table>
<thead>
<tr>
<th><strong>CABINET/UNIT HEATER</strong></th>
<th></th>
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<tr>
<td>Line voltage thermostat</td>
<td>T</td>
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<tr>
<td>Line voltage control valve</td>
<td>T</td>
<td>M</td>
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<tr>
<td>Line voltage aquastat</td>
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<thead>
<tr>
<th><strong>FTR/RADIANT PANELS</strong></th>
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<tbody>
<tr>
<td>Temperature sensor</td>
<td>T</td>
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<tr>
<td>Control valve</td>
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<th><strong>EXHAUST FAN</strong></th>
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<tr>
<td>Control relay/current sensor</td>
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<tr>
<td>Control damper(s)</td>
<td>O</td>
<td>M</td>
<td>T</td>
</tr>
<tr>
<td>Control damper actuator(s)</td>
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<th><strong>NETWORK</strong></th>
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<tr>
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<table>
<thead>
<tr>
<th><strong>120V ELECTRICAL POWER</strong></th>
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<tbody>
<tr>
<td>120V to DDC panels</td>
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<tr>
<td>120V to VAV box</td>
<td>E</td>
<td>E</td>
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<tr>
<td>120V to Operator work station</td>
<td>E</td>
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</tr>
<tr>
<td>120V circuit breaker to DDC Panel</td>
<td>E</td>
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<table>
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<tr>
<th><strong>CONTROL WIRING</strong></th>
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<tr>
<td>DDC panel input/output wiring</td>
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<tr>
<td>DDC panel to motor starter</td>
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<tr>
<td>24V power to dampers/valves</td>
<td>T</td>
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</tbody>
</table>
DIVISION 26 - ELECTRICAL

26 01 00 General Information:

1. These guidelines and standards shall be enforced for new construction, remodels, tenant improvements, retrofits, additions, removals, demolition or any other project requiring electrical change on ASU property. The primary objective of these guidelines is to achieve consistency and accuracy in electrical facilities engineering design through awareness and standardization.

26 01 01 Code and Ordinances:

1. All materials and workmanship shall comply with all applicable Codes, Specifications, Local, State Ordinances, Industry Standards and provision found in this document.

   Applicable Codes and Standards shall include all State Laws, Local Ordinances and the applicable requirements of the following accepted Codes and Standards. Conform to, although not limited to, the following:

   a. International Building Code (IBC)
   c. Uniform Fire Code (UFC)
   d. National Fire Protection Association (NFPA)
   f. National Electrical Testing Association (NETA)

2. Where conflicts occur within different codes the more stringent applicable portion of the conflicting codes shall be used unless written permission is granted by Capital Programs Management Group electrical engineer.

26 01 02 Electrical System Overview – ASU Tempe Campus

1. The Utility Company specifies the location of the service point. At the ASU Tempe Campus, this service point is in four locations:

   a. The Central Plant.
   b. The west substation, located by Parking Structure #3.
   c. The northeast corner of University Drive and Veterans Way, parking lot #57.
   d. The CHP, southwest of Parking Structure #4.

2. The load side of the main APS meter sections is the premises wiring and is the property of ASU. This is classified by ASU as the total load. At the ASU Tempe campus, the service points and the disconnecting means are located in the same section shared by APS by a common buss. The service point is the point on the wiring system where the serving utility ends and where the premises' wiring begins.

3. At the ASU Tempe campus, individual building services shall be classified as part of ASU's primary distribution system and not as the utility service point. The primary electrical distribution system throughout the ASU Tempe campus is an underground system distributed through a network of utility tunnels and/or
underground duct bank systems. The electrical distribution system on campus is a nominal 12.5 KV, 3-wire, Delta connected primary with a 4 wire Wye secondary. The primary distribution conductors feed into distribution transformers, designed to step-down the primary voltage into a secondary voltages bases on load requirements.

4. For new design, voltage for incandescent lighting, receptacles, etc., shall be designed at 120/208 volt, 3-phase, 4-wire, serviced from secondary dry type transformers with 480-volt, 3-phase, 3–wire, Delta primary with a ground sized to the secondary conductors. Transformers may also be 120/208V - 3 phase - 4 wire "Wye" for the entire building requirements. This decision shall be made by the Design Engineer and approved by ASU CPMG A/E Electrical Engineer, and Electrical Services and will be influenced by the relationship between the motor lighting load and the total load within the building.

5. All buildings shall be designed and built with a ground system that references a single point of ground with provisions for expansion. Each new building shall provide the necessary switches and transformers for its connected load. A load analysis shall be performed to determine the adequacy of the primary feeders for interconnection, or upgrade of the primary system. ASU’s primary distribution system conductors shall be sized based on the requirements of Section 26 05 13.

26 01 03 Emergency Power

1. Emergency power for life safety emergency loads is supplied from the following locations:
   a. The Central Plant.
   b. The CHP, southwest of Parking Structure #4.
   c. Seven independent emergency generators throughout the site.

2. Emergency power from the Central Plant is distributed via the utility tunnel system. Emergency power from the Central Plant is distributed at 4,160 volts to selected 4,160/600V or 4,160/480V transformers located throughout campus, to distribution panels for interconnection. New buildings will require a step-down transformer for emergency power; or if feasible, a breaker from one of the distribution panels is all that would be necessary.

3. Emergency power from the C.H.P. is distributed via a underground conduit system. Emergency power from the C.H.P. is distributed at 4,160 volts to selected 4,160-277/480V transformers to distribution panels located in the ISTB1, HAV and Bio Design buildings, for interconnection. New loads connecting to this system shall be approved through CPMG prior to any design work.

4. Standby or legally required systems shall not be connected to the any emergency power systems. These loads shall be powered from a separate system by the within the project and its budget.

5. ASU at the Tempe campus has in place a 600 / 480 volt emergency power system throughout the tunnel system which is in the process of being upgraded to a 4160 volt distribution system and has selectively located 600 volt distribution panels.

6. New buildings must be designed to feed emergency power from the 4160 volt emergency power generator system installed in Central Plant with the use of 4160-277/480 volt step down transformer. Each building will have its own automatic
emergency transfer switch (AETS). Normal power supply will be from the Service Entrance Section at the individual building and will be the primary, or normal, source of power to the AETS.

7. Additional information on Electrical Reliability and Redundancy may be found in Appendix 2: *Electrical Reliability Standards*, found in Section 1 of the *ASU Design Guidelines*.

**26 02 00 General Design Requirements/Recommendations**

**26 02 01 Equipment and Material:**

1. Equipment, and materials, shall be new, unused, without blemish or defect and manufactured not more than twelve (12) months prior to installation.

2. Equipment, fixtures and materials shall be U.L. listed and labeled, or certified by a nationally recognized independent testing laboratory acceptable to the ASU Capital Programs Management Group Electrical Engineer.

3. Materials, fixtures and equipment shall not be specified if they are known to be obsolete, end of life, discontinued or have a spare part supply life less than five (5) years beyond completion of the facility.

4. All drawing symbols must be shown on the drawings in a section describing the symbols and giving specifications of the item.

5. For the purpose of Division 26, Electrical, the term "approved equal" will be the determination of the ASU Electrical Services Supervisor and the Capital Programs Management Group Director, who will have the final decision.

6. ASC Ratings depending upon feeders (as approved by Campus Engineer) to meet calculation (for full calculated loads).

**26 02 02 General Requirements:**

1. A maximum of 4 receptacles will be allowed on each 20 amp circuit, with a dedicated circuit for all appliances such as; copiers, laser printers, microwave and refrigerator circuits.

2. A maximum of 3 circuits is allowed in each conduit for all new installations.

3. Main feeders, or branch circuit conductors shall not be brought into the back of a power panel or switchboard.

4. No underground excavating, digging, drilling, coring, sinking rods, driving spikes, or any work that would move grade level earth will be started until a formal Blue Stake service has been requested and completed.

5. Power supply and identification shall be provided for electric door locks. Control location for monitoring shall be as approved by ASU Lock Shop.

6. No conduit will be smaller than 3/4 inch unless approved by the ASU Facilities Management Electrical Services.
7. Provide conduit sleeves in all floor-to-structure walls for the installation of all conduits that pass through wall. Sleeves shall be 4” for installation of data cabling. Install fire stop at all rated walls matching the walls rating.

8. All drawing symbols must be shown on the drawings in a section describing the symbols and giving specifications of the item.

9. For the purpose of Division 26, Electrical, the term "approved equal" will be the determination of the ASU Facilities Management Electrical Services Supervisor and the Facilities Planning/Management Director, who will have the final decision.

**26 02 03 Installations in Mechanical Rooms and Equipment Locations**

1. Provide adequate safe access and manufacturer’s recommended working clearances for all equipment.

2. Provide for replacement of the largest pieces of equipment without removing permanent walls, large items of equipment or equipment essential to the principal on-going day to day building use.

3. Provide direct access from the exterior for major electrical rooms exceeding 100 net square feet.

4. In phased projects, electrical rooms shall be sized to include equipment for all the phases.

5. Electrical rooms shall have a floor drain.

**26 03 00 Electrical Demolition**

1. Power shutdowns required to perform demolition shall be coordinated with ASU CPMG and Electrical Services Supervisor.

2. All conduit and conductors that are removed under demolition work shall not be reused.

3. At the completion of a project, turn over to ASU all removed electrical devices. Where existing devices are to be removed, the conduit and conductors connecting to them shall be removed all the way back to the nearest remaining device, or back to panelboard.

4. Relocated devices shall have their associated conduits and conductors extended to new location. Install new junction boxes conduit and conductors in order to restore system to operating condition.

5. Where an existing device is to be removed, and it, or its associated box, is connected in series with any remaining downstream devices, install new conduits, conductors, and boxes, as required jumping the removed device. The operation of the remaining devices shall be retained.
26 05 00  Common Work Results for Electrical

Description: Wiring connections to equipment included in other sections.

26 05 01 Package Equipment

1. The contractor or vendor furnishing a piece of packaged equipment with electrical component(s) shall furnish and install the equipment. The electrical contractor will provide the wiring and make the connections to the components.

2. Line control devices will be delivered to the electrical contractor by the contractor furnishing the equipment, and the electrical contractor will mount and connect these items.

3. Motor disconnect switches circuit breakers, variable frequency drive, for package equipment will be furnished, installed, and connected by the electrical contractor where required.

4. The control items, wiring diagrams, and the responsibility for correct installation and function of the control system shall be covered under that section of the project specifications where the equipment is specified to be furnished.

5. The electrical contractor will run electrical conductors to a designated location near the controller and terminate in a disconnect switch or breaker of a specified size and type.

26 05 02 Elevators

1. Electrical wiring of elevators and/or cranes will be done by an Arizona State licensed elevator contractor.

2. The electrical contractor shall provide a convenience outlet and light in the elevator pit and elevator machine room; and where emergency power is available, shall be connected to the emergency power panel. Elevator raceways will be installed per this division.

3. The safety switch for the elevator equipment shall contain normally closed and normally open dry auxiliary contacts that operates with the blades of the safety switch.

4. Provide an elevator shunt-trip device that upon activation of a heat detector in the elevator machine room or within the elevator shaft will disconnect power to the elevator machine room. Each shut-trip circuit breaker

26 05 03 Special Systems

Conduit and wiring shall be installed as required by this division for telephone, fire alarm systems, program clock system, TV antenna systems, telecommunication systems, emergency power, and central control system. Telephone systems as per ASU Telecommunications Services.
Medium Voltage Cables:

Description:  Medium voltage cable and accessories for systems rated above 600 volts to 15,000 volts.

26 05 13.01 Cable

1. Medium Voltage Cables shall be new, 5kv & 15kv single copper compact stranded conductor EPR shielded power cable rated at 5000 & 15000 volts, 133% level type MV-105. three-phase conductors as per electric services direction, with a minimum #4/0 bare ground. Phase conductors shall be suitable for use in wet and dry locations in conduit, underground ducts, direct burial, cable tray and aerial installations. ASU standard specifications for medium voltage cable are below.

MEDIUM VOLTAGE CABLE SPECIFICATIONS

Scope

This specification covers single conductor shielded power cable insulated with an ozone and discharge resistant, flexible, rubber-like thermosetting dielectric.

The cable shall be suitable for use in wet and dry locations in conduit, underground duct systems, cable tray and aerial installations. The cable shall be rated 105 degree C for normal operation, 140 degree C for emergency overload operation and 250 degree C for short circuit conditions. Emergency overload operation may occur for periods up to 1500 hours cumulative during the life of the cable.

Standards:

All cable shall conform to the current standards:
   a. Insulated Cable Engineers Associated (ICEA) S-94-649
   b. American Society for Testing and Materials (ASTM)
   c. Association of Edison Illuminating Companies (AEIC) CS-6, latest edition
   d. UL MV-105.

Basic Construction:  1/C compact stranded copper, triple tandem extruded semi-conducting ethylene-propylene rubber strand shield, .220” EPR insulation for 15kv and .115” EPR for 5kv, extruded semi-conducting ethylene-propylene rubber insulation shield, shielding tape, #20 drain wires, separator tape and overall jacket.

Conductor: Conductor shall be uncoated copper compact stranded per ASTM B-496.

Conductor Shield: Conductor shield shall be extruded layer of semi-conducting EPR thermosetting compound with a volume resistivity not in excess of 100 ohm meter at 90 degree C shall be applied over the conductor. The compound shall have a minimum elongation after an air oven test at 121 degree C for 168 hours of 100% and the brittleness temperature not warmer than _40 degree C.
Insulation: The Insulation shall be EPR; a red colored flexible thermosetting dielectric based on an ethylene propylene elastomer. The ethylene content of the elastomer used in the insulation compound shall not exceed 72% by weight of ethylene nor shall the insulation compound contain any polyethylene, both features to limit the degree of susceptibility to treeing experienced by highly crystalline materials. The cable manufacturer shall compound the insulation in its own facility using a closed system to insure maximum cleanliness. The EPR insulation shall be triple tandem extruded with the EPR based conductor and insulation shields to prevent inter-surface contamination. The extrusion operation shall be performed by three separate in-line extruder heads thereby permitting the measurement and accurate individual control of the wall thickness of each layer of compound as the cable is being manufactured.

Insulation Shield: The insulation shield shall be an extruded semi-conducting EPR compound with a volume resistivity not in excess of 10 ohm meters at 90 degree C when tested per ICEA S-94-649. It shall be clean stripping from the insulation when preparing terminations and splices.

Metallic Shield: A single 5 mil copper tape shall be helically wrapped with a 12-1/2% nominal overlap along with the appropriate number of #20 AWG drain wires to double the phase to ground fault capacity of the 5 mil copper tape.

Jacket: The overall jacket shall be thermoplastic black PVC for conduit or direct burial.

Corona: Each reel of completed power cable shall comply with the maximum partial discharge test and shall be performed in accordance with the procedures of Section F of AEIC CS-6. Manufacture is required to submit the X-Y recording graph showing flat line corona test results.

Quality assurance: The medium voltage cable shall be manufactured and tested under the control of a Quality Assurance program which meets the requirements of Section 10 degree CRF50, Appendix B of the Federal Register as defined in ANSI N45-2.

Each reel of completed power cable shall comply with shall be newly manufactured (no more than 12 months old) and shall bear a tag containing name of manufacturer, NEC designation, year of manufacture and all information noted in this section.

Cable manufacturer shall be Okonite Okoguard®-Okoseal® MV-105, or approved equal.

26 05 13.03 Splices and terminations
1. All splices and terminations shall be performed by qualified cable splicer's who have had at least eight (8) years experience in the “Cable Splicer” classification and at least five (5) years experience with this type of cable. The qualifications of the cable splicer's shall be submitted for approval to the ASU Electrical Services department.

2. Provide molded rubber straight type separable connector-cable joints, cable bushing adapters for in-line cable connections to sectionalizing switches and stress cones for applications on EPR, insulated power cables. The connectors shall be fully dead front.

3. Splice and termination kits shall be approved by ASU Electrical Services Supervisor. University personnel shall be notified 72 hours in advance so that they may observe each splice or termination being made.

26 05 13.04 Warranty

1. Manufacturer shall offer a 40 year warranty against dielectric breakdown due to materials or workmanship. The warrantee period shall be from the date of shipment if installed, terminated, and operated within acceptable industry practices and standards. In the unlikely event the cable is found to be defective in either material or workmanship, as mutually agreed upon by the purchaser and the manufacture, the manufacture shall agree to repair of to replace the defective length(s) of cable during the 40-year warranty. This warranty shall be based upon the cable being installed and field tested in accordance with the manufactures procedures.

26 05 19 Low-Voltage Electrical Power Conductors and Cables (600V and Less)

Description: Building wire and cable with insulation rated 600 volts and less.

1. Insulated wire conductors for circuit voltage 600 volts or less, shall be stranded copper, minimum size #12 AWG. Provide type THWN or THHN-2 wire and cable #4/0 AWG size and smaller in dry locations. Provide type THWN-2 wire and cable larger than #4/0 AWG size in wet locations. All conductor sizes shall be fully rated for the entire length of the feeder run. Conductors over sized for voltage drop may be reduced near the end of a conductor to allow termination at devices. Tap conductors from main feeder shall be reduced and allowed by the Code.

2. All raceways shall be supplied with the proper NEC sized, green or bare copper, grounding conductor.

3. All wire and cable shall be color coded as follows:

<table>
<thead>
<tr>
<th>120/208 volt</th>
<th>480/277 volt</th>
</tr>
</thead>
<tbody>
<tr>
<td>A-PHASE – BLACK</td>
<td>A-PHASE - BROWN</td>
</tr>
<tr>
<td>B-PHASE – RED</td>
<td>B-PHASE - ORANGE</td>
</tr>
<tr>
<td>C-PHASE – BLUE</td>
<td>C-PHASE - YELLOW</td>
</tr>
<tr>
<td>NEUTRAL – WHITE</td>
<td>NEUTRAL - GRAY</td>
</tr>
</tbody>
</table>
4. All wire and cable #8 AWG and smaller shall have color coded insulation or jacketing as noted above. Where the above noted colors cannot be provided in the wire and cable insulation or jacket, above #6 AWG, colored tape in the color designated above shall be placed on the cable at all exposed terminals, loops, and splices.

5. When a 20-amp, single pole circuit for power and lighting exceed 100’ for 120-volt circuits or 150’ for 277-volt circuits from device to panelboard, use #10 AWG wire or larger as required to achieve a maximum 3% voltage drop at full circuit capacity.

6. For all non-sinusoidal loads install a separate identified neutral conductor for each phase conductor. Conductors for non-sinusoidal loads shall be a minimum size of #10 AWG for 20-amp circuits.

26 05 19.01 Wire Terminations, Splices and Connections

1. All connections to circuit breakers and switches and all terminations and splices in wires shall be made as noted below:

   a. For # 12 solid wire: Formed around binding post or screw.
   b. For # 12, #10 and #8 stranded wire: Proper UL approved lug, locking tongue compression lug, or approved connector on the breaker binding post or screw.
   c. For #6 wire and larger - Burndy "Qiklug" Type QDA, or approved equal, with round flange solderless lug, or connector on breaker (hex wrench or screw type lug). Circuit wiring connections to fixture wire shall be made with pressure-type solderless connectors such as Buchanan, Scotchlock, wire nut or approved equal.

2. Splices in wires:

   a. For # 6 wire and larger – Use Burndy type QPR, or approved equal. For # 8 wire and smaller – Use Buchanan, or equal, pressure - type solderless connectors complete with insulator and security ring or "PIGTAIL" splices as described below.
   b. Splices for small wires shall be "PIGTAIL" splices with separate tails of correct color and size. There shall be at least 6 inch of tail left out of box after splice is made up.

3. Underground splices shall be limited and only with the approval of ASU Electrical Services Supervisor, and Capital Programs Management Group electrical engineer prior to installation.

26 05 29 Hangers and Supports for Electrical Systems

1. Supports, hangers, anchors, clamps, restraints and other components shall be supported from the building structural members and not from other support systems or non structural elements, unless approved by ASU Electrical Services.
2. Hangers and supports shall be approved standard design and shall be adequate to maintain the supported load in proper position and alignment under operating conditions.
3. The use of powered driven fasteners (and shot pin) is strictly prohibited.

25 05 33 00 Raceway and Boxes for Electrical Systems

25 05 33 01 General

1. All electrical wiring shall be placed in raceways.

2. No non-metallic cable or cords will be accepted. No flat wire systems, BX, ENT, MC or similar product will be allowed.

3. In general, raceways are expected to be Rigid Galvanized Steel (RGS), Rigid Nonmetallic Conduit (PVC), or Electrical Metallic Tubing (EMT) conduit as noted in this section and shall follow the recommendations of the NEC for installation, use and protection. The use of Intermediate Metal Conduit (IMC) is not permitted.

4. Suspended lights and drop in lights in suspended ceilings may use 3/8 inch UL approved factory installed whips. Whips lengths shall not be more than 6 feet in length and use only with the approval on ASU Electrical Services on a job by job basis.

5. All conduit sizing will be in accordance with Appendix C of the NEC based on the conductor size, type and number. No conduit installed above ground will be smaller than 3/4 inch, 1” for underground installations, unless approved by the ASU Electrical Services.

6. All raceways shall be supplied with a 100% sized grounding conductor, and sized to the secondary loads.

7. Flexible steel conduit will be used only for chasing existing walls. Minimum size for steel flex conduit shall be ½ inch unless prior approved by ASU Electrical Services Supervisor, and Capital Programs Management Group.

8. Flexible steel conduit use in applications other than chasing existing walls shall have a maximum length of six feet, and shall be use only with prior authorization by ASU Electrical Service. ¾” will still be the nominal size.

9. Underground conduits and ducts shall be enclosed in a concrete envelope. Trenching, back-filling and concrete work shall be done under this division of the work and meet 95% compaction.

10. PVC Schedule 40 shall be used for main power and telephone underground feeders. PVC Schedule 40 shall not be used above ground without approval of Electrical Services Supervisor.

11. Galvanized steel ELLS and sweeps shall be 36 "minimum radius for 2” ~ 2-½ "inch conduit diameter and 48” minimum radius for 3” ~ 5 conduit diameters and shall be used with all schedule 40 PVC conduit. All steel conduits will be half wrapped with
an approved 20 mil tape for a total of 40 mil conduit coverage from ground level to the PVC.

12. PVC conduit may be used in concrete slabs or approved hazardous locations but shall not be used as stub ups.

13. Rigid steel shall be used in masonry, hollow tile wall construction and stub ups. PVC conduit shall not be used inside buildings, inside walls or above ceilings, without approval by the Electrical Services Supervisor.

14. Electric metallic tubing (EMT) may be used in furred spaces and in metal or wood stud walls, but not over 2" diameter in size. Where metallic tubing is used, connectors shall be steel set screw or steel water-tight, compression type, depending on location. The use of Cast fittings will not be allowed.

15. Conduits must be kept within the furring lines established on the architectural drawings, unless conduits are shown as exposed. Conduits 2" and larger shall be rigid galvanized steel unless otherwise approved by the Electrical Services Supervisor.

16. The contractor shall provide all necessary sleeves and chases required where conduits pass through floors, or walls. All sleeves shall be fire sealed in accordance with the fire rating of the wall or floor, and finish to match adjacent surfaces.

17. No conduit placed in a concrete slab shall have an outside diameter greater than 25% the thickness of the slab. No conduit shall be embedded in a slab that is less than 3-1/2" thick except for local offsets, and shall never be placed between the reinforcing steel and the bottom of the slab.

18. In office and academic buildings, no conduit shall be run in a concrete slab. These conduits must be run overhead, even where they serve only a dead end outlet. No exceptions.

19. In dormitory type buildings, conduit may be permitted to run in concrete slab after a written request outlining specific design requirements is reviewed and approved by ASU Electrical Services.

20. All exposed conduits shall run parallel and perpendicular to building walls and ceiling.

21. Rigid aluminum conduit may be used upon specific approval from ASU Electrical Services, and shall conform to the following specifications:

22. Conduit shall be extruded from primary 6063 alloy to a temper T-42. Copper content shall not exceed 1/10 of 1%. Threads shall be cut true and shall be covered with petroleum base lubricant containing powdered zinc. Couplings shall be forged from primary 6063 alloy and shall be threaded and chamfered. Each length of conduit, elbow, bend and nipple shall be marked in accordance with UL standards.
23. All conduits shall be supported in an approved NEC manner on its own support system fastened directly to the structure without the use of power actuated tools, such as ram sets.

24. Conduit, 1” or larger, shall be supported with UL approved conduit hangers and two steel 3/8” all-thread rods, supporting a minimum 14” long unistrut trapeze.

25. Where conduit is supported from a wall, UL approved one or two-hole wall straps shall be used or UL approved conduit clips. Clips shall be a maximum of 6’ apart.

26. Where multi-conduits follow the same run as piping, trapeze hangers (unistrut) may be utilized in common with other trades piping systems, with provisions made for proper spacing and the use of UL approved conduit clamps. Trapeze style hangers shall have two 3/8” steel all-thread rod supports for each section of unistrut, minimum. Unistrut shall be 1-5/8” x 1-5/8” minimum.

27. Suspending conduit from the bottom of the unistrut will be avoided when at all possible.

28. Conduit in caustic or corrosive areas or as directed by Electrical Services, will be PVC coated rigid Rob-Roy conduit with an enamel coating inside the conduit.

26 05 33 03 Boxes

1. All device, fire alarm, and special system junction boxes shall be 4” square 2-1/8” deep minimum. All boxes in walls shall be securely fastened per the requirements of the code. All boxes shall be galvanized steel, PVC boxes will not be allowed unless used in caustic or corrosive areas with prior approval of ASU Electrical Services.

2. Blank cover plates will be clearly and legibility labeled on both sides with permanent marker indicating feeder panel and breaker identification. Labels shall be on machine printed tape. Use 1/4” wide clear tape with black lettering. Contractor shall submit proposed labeling system for approval.

26 05 53 Identification for Electrical Systems

1. All electrical equipment including, but not limited to switchboard and panelboards, motor starters, disconnect switches, relays, lighting and power panels installed, shall include locations of breakers feeding them by room and breaker number, and all apparatus used for the operation or control of power circuits, appliances or equipment, shall be properly and permanently identified by means of description engraved nameplate.

2. Nameplate material shall be 3/32” thick engraved, laminated plastic or Micarta type with white letters engraved through the black background, except on emergency systems background shall be red and include the word “EMERGENCY.” Letters shall be 3/16” high for devices, and minimum ½” high for equipment and enclosures. Nameplates shall be mechanically secured with self tapping screws, bolts or rivets. Adhesives are not acceptable.
3. Identify all motors and other pieces of electrically operated apparatus with \( \frac{3}{4} \)" minimum height painted stencil lettering painted directly onto motor or apparatus. Color to contrast with background color.

4. Equipment, boxes and enclosures containing conductors of systems 4160-volt and higher shall be provided with nameplates with a red plastic laminated nameplate with 2" high white core letters inscribed “HIGH VOLTAGE” in 1/2" letters. The nameplate shall contain the following information; Circuit Voltage, Circuit Number, and Circuit Source.

5. Lighting and receptacle panel circuit breakers shall be identified by permanently fixed numbers such as individually engraved metal numbers, or numbers etched under an acrylic plastic sheet. Stick-on-numbers such as "Tape Writer" will not be acceptable.

6. Panelboard shall have a type written directory indicating circuit numbers, equipment served and room number of the area served. Directory cards shall be edited and maintained during the course of construction to keep an accurate, up to date record of each feeder or branch circuit. Directory cards shall be installed in an existing directory holder or if not available installed under clear plastic in a suitable frame on the inside of door.

7. All special outlets and remote control switches shall be identified by engraving descriptive markings on flush plates.

8. All such nameplates or lettering shall be submitted to ASU Electrical Services before being secured or printed on the apparatus.

9. All room number designations shall be reviewed with Capital Programs Management Group and the Office of the University Architect. Room numbering must be completed prior to typing the circuit directories since the room numbers on construction drawings may not agree with the ASU schedule of room designations.

10. All receptacle cover plates and blank cover plates, shall be labeled and indicate the source panel and circuit breaker number. Labels shall be made with a “Dymo Rhino RO 5000 ®”, or approved equal.
26 06 50 ELECTRICAL & LIGHTING WATTS / FOOTCANDLES PER S.F. GUIDELINES

Description:
This section includes general design parameters for conceptual calculation for electrical and lighting loads, in watts per square foot and foot candles.

### Footcandles – Watts Per Square Foot

<table>
<thead>
<tr>
<th>Description</th>
<th>Footcandles – Watts Per Square Foot</th>
</tr>
</thead>
<tbody>
<tr>
<td>Library reading rooms</td>
<td>50 - 1.0</td>
</tr>
<tr>
<td>Calculating rooms</td>
<td>50 – 1.0</td>
</tr>
<tr>
<td>Drafting rooms</td>
<td>75 – 1.9</td>
</tr>
<tr>
<td>Accounting rooms</td>
<td>50 – 1.0</td>
</tr>
<tr>
<td>Proofreading rooms</td>
<td>75 – 1.5</td>
</tr>
<tr>
<td>Classrooms</td>
<td>50 – 1.0</td>
</tr>
<tr>
<td>Laboratories</td>
<td>75 – 1.0</td>
</tr>
<tr>
<td>Seminar rooms</td>
<td>50 – 1.0</td>
</tr>
<tr>
<td>Offices</td>
<td>50 – 1.0</td>
</tr>
<tr>
<td>Shops</td>
<td>50 – 1.0</td>
</tr>
<tr>
<td>Toilet rooms</td>
<td>20 - 0.4</td>
</tr>
<tr>
<td>Kitchens</td>
<td>30 - 0.6</td>
</tr>
<tr>
<td>Locker rooms</td>
<td>20 – 0.4</td>
</tr>
<tr>
<td>Store rooms</td>
<td>20 – 0.4</td>
</tr>
<tr>
<td>Corridors, Academic &amp; Offices - 25</td>
<td>10 – 0.2</td>
</tr>
<tr>
<td>Dormitory</td>
<td>30 – 0.6</td>
</tr>
<tr>
<td>Machine room</td>
<td>30 – 0.6</td>
</tr>
<tr>
<td>Building entrances, outside</td>
<td>30 – 0.6</td>
</tr>
<tr>
<td>Building entrances, inside</td>
<td>same as corridors</td>
</tr>
<tr>
<td>Parking Structures and Lots</td>
<td>3.0</td>
</tr>
<tr>
<td>General Site Lighting</td>
<td>1.5</td>
</tr>
<tr>
<td>Open parking facilities</td>
<td>2.0</td>
</tr>
</tbody>
</table>

Supplemental local illumination shall be provided for wherever required to give the following local intensities:

<table>
<thead>
<tr>
<th>Description</th>
<th>Intensity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shop work at machines or benches</td>
<td>75</td>
</tr>
<tr>
<td>Displays</td>
<td>75</td>
</tr>
<tr>
<td>Demonstration tables or areas</td>
<td>60</td>
</tr>
<tr>
<td>Elevator Equipment Rooms</td>
<td>30</td>
</tr>
</tbody>
</table>

26 09 13 Electrical Power Monitoring and Control:

1. An electrical watt-hour meter with demand register shall be provided. This meter shall be connected on the secondary of the transformer to meter all power consumption. The meter shall be located in an accessible space near the main distribution panel. For services over 200 amps, transformer rate meters are to be used: CT accuracy shall be calculated on the following, low range shall be 50% of service capacity and high range not over 100%. Accuracy class shall be for revenue grade metering as specified in C57.13 ANSI 0.3 and B0.5 burden (minimum) with continuous current thermal rating factor of 2.0. CTs shall be utility monitoring grade.
CTS may be in the switchboard ahead of all connections or at the transformers, and must be readily accessible at either location. Provide a Superior test shorting block with a nonconductive cover to match campus standard behind the front face of the main switchboard metering section or at meter location. Bring all three potentials to the test shorting block. Meters shall be 3 phase, 4 wire meter with a neutral for 4 wire services. Meter shall have an LED display to six digits with kilowatt and megawatt indication. Watt-hour meter shall be a Pulse Initiator type, with a microprocessor base, self contained. Designed to monitor and display all electrical parameters.

**Approved Manufacturer:** Cutler Hammer IQ-6600 series, billable quality meter, as approved by ASU Electrical Services.

2. All meters will display all phase to phase and phase to neutral voltage, current per phase, total harmonic distortion, power factor, Var.'s, total watt usage, total kilowatt hours and megawatt hour indication. The meter will connect and communicate with existing Cutler Hammer Power Net system located in Central Plant.

NOTE: There are requirements for ASU's EMS system. See Division 25 51 00.

**26 10 00 Medium Voltage Electrical Distribution**

**26 10 01 Medium Voltage Duct Systems**

1. All primary voltage systems shall be in raceways, meeting the requirements of the NEC and ASU Electrical Design Guidelines and Standards.

**26 10 01.01 Minimum Requirements:**

1. A minimum of two rigid galvanized five inch conduits and one spare 5” conduit shall be run from a designated source to the inside of each building. They shall be buried and concrete encased. PVC conduit beneath and exterior to the buildings with galvanized steel 90’s and transition pieces may be acceptable.

2. Concrete encasement shall be a minimum of 2500 PSI with an integral color tint (red).

3. Concrete encased conduits shall be installed in pairs (i.e. multiples of two).

4. A polypropylene pull wire (2500 lbs. PSI pre-lubed) shall be provided and installed in spare 5-inch conduit.

5. All concrete encased duct systems shall terminate in an underground vault except where direct entry into building transformers or switches as permitted.

6. Any primary voltage conduit run with over 180 degrees of bends shall require a vault or pull box. Any conduit bend of 15 degrees or more will be galvanized steel with 1/2 lap 20-mil tape for a 40-mil total thickness when installed in a duct as a transition or turn.

7. All concrete encased ducts shall have a vinyl "DANGER HIGH VOLTAGE" warning tape buried in the trench parallel with the duct run and located 12 inches above concrete envelope.
8. Primary Conduit inside buildings shall be 5" galvanized rigid steel with one spare 5" conduit supported at 5' on-center from the overhead structure. All bends and sweeps shall be rigid long sweep 48" radius type. Rigid conduit shall be by an approved manufacturer.

9. Primary Conduit outside of building structures shall in each case be reviewed by ASU Electrical Services. The 5" conduit, with a 5" spare shall be 5" minimum in diameter. It may be Schedule 40 PVC in a concrete envelope with 48" radius galvanized steel elbows and sweeps.

26 10 01.02 Vaults

1. Minimum vault size shall be 16' x 10' x 8' inside dimensions. Maximum spacing of vaults shall not exceed 320 feet from center to center.

2. All roof loading shall conform to the State of Arizona Highway Specifications for H-20 loading.

3. Vaults with switch gear or where switch gear may eventually be installed shall be 12' x 12' x 7'-6" high minimum inside dimension.

4. All vaults shall have top, walls, and bottom composed of reinforced concrete.

5. Rings shall be made of gray cast iron or "hot dipped" galvanized steel. A machine finished cover set shall be provided to ensure a perfect joint between the frame and the cover.

6. Vault covers shall be equipped with lifting handles and shall be 48-inch diameter minimum hinged lid traffic rated.

7. Three horizontal runs of superstrut series #C300 or equivalent shall be embedded in each wall of the vault.

8. Cable pulling irons shall be installed for each duct or future duct systems. Vaults shall be provided with a rock drain dump, with a sloped floor to a sump. A cast iron grating over the sump shall be provided.

9. Each vault shall be equipped with a permanently installed hot dipped, galvanized steel ladder.

10. Ladder rungs shall be spaced 12 inch on centers and shall be corrugated, knurled, dimpled, coated with skid resistant material or otherwise treated to minimize the possibility of slipping.

11. Minimum ladder width between side rails shall be 12 inch. Side rails shall be a minimum 1 1/2 inch x 1-1/2 inch x 3/16 inch thick channel size. Ladder rungs shall have a minimum 5/8 inch diameter.

12. The contractor shall furnish and install two 10-foot long chemical rods. The chemical rods EPA approve UL listed 40 year life expectancy will be installed horizontally at diagonal corners along the exterior of the vault with a minimum spacing of 10 feet.
between them. They shall be attached with Burndy HYGROUND crimp connectors to terminal points inside the vault and connecting to the ground ring inside the manhole. The penetration through the vault shall be sealed with link seal or equivalent following manufacturer’s specifications.

13. In each vault, furnish and install vertical cable rack risers (six for each wall).

14. Risers shall be hot dipped galvanized, heavy duty, Hubbard #2225 with bolt fastening holes spaced at 25 1/2 inches. Mount racks to superstructure embedded in walls of vault. On each riser described above in each vault, furnish and install a heavy duty lock type hook, Hubbard #2233, 14 inch extension. On each hook furnish and install three maple insulators.

15. Each unused duct bank running from a vault to a building shall be fitted with an approved cell plug fitted to make a watertight seal.

16. Cells through which cable is installed shall be plugged with approved mastic and shall be watertight.

17. Unused corners of each vault shall be provided with a 16 inch x 16 inch thin wall block out for the future installations of additional duct banks.

18. All switching or transformer vaults shall be constructed in accordance with the NEC.

19. A visible ground bus shall be established in all transformer vaults. Bond all metallic piping systems at one point. A uffer ground may be used in conjunction with chemical ground rods. Equipment access to all vaults shall be provided with openings large enough to remove and install equipment. A personnel door, a minimum of 48 inches wide 90 inches tall shall be provided into vaults accessible from the interior of buildings. The location of the personnel door must be such that access is possible to either switching or transformer vault. Each vault shall have all the lighting connected to the emergency lighting system; lighting shall provide a minimum of 50 foot candles. All lights shall be switched from inside the vault. Each vault shall have one duplex receptacle connected to the emergency system on dedicated 20 amp circuit. Ventilation shall be in accordance with the NEC requirements. Natural ventilation is desirable and forced draft ventilation shall be avoided.

26 12 00 Medium-Voltage Transformers

26 12 01 Liquid Filled Medium Voltage Transformers

1. Liquid filled transformers shall be three-phase, 60 HZ, 65 DEG. C. temperature rise, liquid-filled, self-cooled, pad-mounted distribution transformers, rated at 45 KVA through 2500 KVA; medium-voltage 15,000 volts and below, for operation of three-phase secondary voltage, 480/277 and below with all four secondary leads brought out through insulated bushings.

2. The primary side of the transformer shall be fused externally. Acceptable fuses stated. Bayonet fuse line - explosion type, drywell full range current limiting fuses.
3. Transformers shall be manufactured in accordance with the latest revisions of applicable ANSI and NEMA specifications.

4. Wound cores shall be of the five-legged design; stacked cores shall be five-legged design. The windings shall be copper.

5. The transformer cooling and insulating fluid shall contain no PCB’s and be environmentally safe enviro-temp, FR 3 or equal. This shall be stated on a permanent corrosion-resistant nameplate mounted in the low voltage compartment.

6. Oil filled transformers shall have secondary containment capable of 150% of transformer oil capacity. Containment shall have a valve and nipple to allow for manual drainage.

26 12 01 01 Voltage Ratings

1. Primary voltage rating shall be 12470 GR./7200 (95 KV BIL) Delta primary or as otherwise stated. Secondary voltage rating shall be (30KV BIL) minimum 208 Y/120 or 480 Y/277, or as otherwise specified.

26 12 01 02 Tap Ratings

1. Transformers shall be furnished with TWO 2-1/2% full capacity taps above and below rated voltage center tap at rated voltage unless specified otherwise by ASU electrical services. The Tap Changer shall be ganged, externally operable with a standard hot stick, and suitable for de-energized operation only. The Tap Changer shall be set on rated voltage tap at the factory and shall be secured to prevent inadvertent change from this position. The operating handle of the medium-voltage Tap Changer shall be located above the low or medium-voltage bushings.

2. New transformers shall have an externally operated load-brake oil immersed rotary switch. Three one for “A” side one for “B” side and on for transformer.

26 12 01 04 Transformer impedance

1. Transformer impedance shall be as follows:

<table>
<thead>
<tr>
<th>Transformer Rating KVA</th>
<th>%Z</th>
</tr>
</thead>
<tbody>
<tr>
<td>75-225</td>
<td>2.0%</td>
</tr>
<tr>
<td>300-500</td>
<td>4.5%</td>
</tr>
<tr>
<td>750 – 3000</td>
<td>5.75%</td>
</tr>
</tbody>
</table>

2. The pad-mounted, compartmental-type transformers shall consist of the Transformer tank, medium-voltage cable terminating compartment, and the low voltage terminating compartment. All three of these components shall be assembled as an integral unit.

3. Provisions shall be provided for lifting the complete transformer with a margin of safety of at least five times the weight of the transformer without requiring additional hardware (bolts, etc.) for the attachment of slings or ropes. Construction of the unit
shall be such that it can be lifted, skidded and slid into place on the mounted pad without disturbing the entrance cables. Suitable jack boosed or equivalent jacking facilities shall be provided on the tank. Vertical clearance for a jack shall be 1-1/2 inches minimum, 3-1/2 inches maximum. Transformer base shall be arranged for rolling in two directions: Parallel to and at right angles to the center line of the high-voltage bushing. The transformer tank shall be of sufficient strength to withstand a pressure of 7 PSI without permanent distortion. Bolt-on access handhold(s) or cover shall be provided on transformers rated 500 KVA and larger.

4. The finish shall be pad-mount green in color, Munsell 7 GY 3.29/1.5 and shall conform to the performance requirements of draft 6 of the proposed EEI finish guidelines for pad-mounted equipment. The contractor shall provide the manufactures certified test reports for the finish with the initial proposal. Further test results shall not be required unless the finish is changed in either application or method of composition. A stainless steel base to minimize corrosion shall be applied.

5. The transformer tank base shall be raised above the pad to protect the bottom finish during installation and to minimize corrosion due to moisture accumulation.

6. No portion of the tank or protruding appurtenances shall trap and hold water after submersion.

7. The nameplate shall be corrosion-resistant and mounted in the low voltage compartment.

25 12 13.05 Tank-Grounding

The tank-grounding provision shall consist of:

1. For 500 KVA and below; Two steel pads, each with 1/2 inch-13 NC tapped hole, 7/16 inch deep. Long enough too allow all conductors to be crimp lugged and bolted to ground bar.

2. For 500 KVA and above; A minimum of two unpainted, copper-faced steel or stainless steel pads, 2 inches x 3-1/2 inches, each with the holes spaced on 1-3/4 inch centers and tapped for 1/2 inch NC thread. The minimum thickness of the copper facing shall be 0.015 inch. Minimum threaded depth of holes shall be 1/2 inch.

3. Ground pads shall be welded on the transformer base or on the tank wall near the base, one in the high-voltage compartment and one in the low-voltage compartment. In the cases where the transformer tank and compartments are separate, provisions shall be made for electrically connecting them.

4. Cooling fins shall be arranged so that partial covering by debris shall not materially hinder cooling.

5. Each transformer shall be provided with two hold-down clamps for securing the transformer to the pad.
6. A suitable marking inside the tank shall indicate the correct oil level at 25 deg. C temperature with an externally read liquid level gauge.

7. The overall dimensions of the transformer, including cooling fins, shall be approved by ASU Electrical Services.

26 12 16 Dry Type Medium Voltage Transformers

1. Transformers shall generally be ventilated dry type, silicon resin encapsulation and process shall apply a four dip protective shield of silicon resin to the coils. Transformers shall be NEMA rated with 220 C. insulation. Primary transformers shall be an integrated assembly, including primary switching transforming and distribution sections. A minimum K 15 and shielded transformer should be used where non-linear loads of an unknown value is expected. All other K factors shall be designed to known loads with the use of supplemental surge arrestors. All non linear load transformers shall be shielded.

2. Transformers shall be rated at 12,470V, at 95 BIL with 5 Tap 2-1 1/2% up and 2-11/2% down center tap at rated voltage 12470 from rated voltage on primary side. Generally, main power center transformers shall be dual rated and fan cooled with internally mounted fans controlled by a coil embedded thermocouple with a "MANUAL"- "OFF"- "AUTO" control switch mounted in face of the transformer cabinet.

3. Transformers shall have a centigrade digital LED or LCD display temperature and fan control, indicating coil and core temperature, mounted on the face of the transformer cabinet oil type transformers are required under special conditions, their use, type and specifications will be approved by ASU Electrical Services.

4. Main service transformers shall be bonded and shall have switches with fuse protection on primary and secondary sides.

26 12 16.01 High-Voltage And Low-Voltage Compartments

1. High voltage terminal compartments shall be dead front construction, full-height, air filled compartments with hinged doors. They shall be located side-by-side and shall be separated by a steel partition.

2. There shall be separate doors covering the primary and secondary compartments. The door covering the primary shall be capable of being bolted or padlocked, and these fastenings shall be inaccessible when the secondary door is closed. The secondary door shall latch at three points, and the handle shall be capable of being padlocked with a penta head bolt.

3. Both compartment doors shall be equipped with stops for holding each door in a 90 degree open position. The stops shall be captive to prevent loss of the device and for convenience.

4. The locking mechanism shall accept an American Lock Company series 5260 padlock with a 3/8 inch x 1-1/8 inch shackle.
5. Doors on the high-voltage and low-voltage compartments shall be of sufficient size to provide adequate working space when open.

26 12 16.02 Medium Voltage Switching

1. An oil-immersed rotary switch, rated at 200 amp, 300 amp, or 400 amp shall be supplied. The switch shall be a load-brake inside the transformer and load-make design and hook stick operable. Switches shall be for the following operation:

   a. Radial feed units shall have 3 switch wired directly behind the primary bushings.
   b. Switching shall not allow for momentary de-energization of the unit
   c. (4-position rotary switches allow for momentary de-energization and are not acceptable).

2. Loop feed units shall have three single LBOR switches (one for “A” side, one for “B” side, and one for transformer) and shall allow the following switching selections:

<table>
<thead>
<tr>
<th>Switch A closed</th>
<th>Switch B closed</th>
<th>Transformer switch closed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Switch A closed</td>
<td>switch B closed</td>
<td>transformer switch open</td>
</tr>
<tr>
<td>Switch A closed</td>
<td>switch B open</td>
<td>transformer switch closed</td>
</tr>
<tr>
<td>Switch A open</td>
<td>switch B open</td>
<td>transformer switch closed</td>
</tr>
<tr>
<td>Switch A open</td>
<td>switch B closed</td>
<td>transformer switch open or closed</td>
</tr>
</tbody>
</table>

26 12 16.03 Bushing and Terminals

1. The medium-voltage phase connection shall consist of externally clamped high voltage bushing wells rated at 200 amp or 600 amp dead brake integral bushing and 200 amp load break inserts conforming to ANSI C57.19.01 and C57.1200 latest revision.

2. Bushing inserts for transformers shall be rated at 200 amp at 15 KV, or 600 amp at 15KV.

3. The medium-voltage winding neutral connection (Ho) shall be such that separation between "HO" and ground can be accomplished either by use of an internal connection, below oil-level, and a ground pad accessible through a handhold or through a primary bushing brought out below the primary bushing wells and grounded externally. If the high-voltage neutral is brought out through a bushing, it shall be located so it will not interfere with the primary cables. There shall be no permanent connection between Ho and Xo.

4. A fully insulated, low-voltage neutral bushing shall be provided in accordance with ANSI C57.12.26, latest revision.

5. Low-voltage line and neutral terminals shall be braced in such a manner that when the number of cables shown are connected, no structural problems shall develop.
6. Low-voltage spades shall be copper or tin-plated copper. The dimensions and locations of the bushings shall be as indicated in ANSI C57.12.26, latest revision.

7. The medium voltage bushing wells and low voltage bushings shall be replaceable in case of damage. Replacement may be either external or internal through a handhole. External replacement shall be accomplished using normal hand tools (not special) and reasonable amount of force. Welded bushing wells are not acceptable.

8. All units shall have provisions at the medium voltage entrance for attachment of a hold down bail.

9. The calculated load on load brakes, bushings, and terminals shall not exceed 80% of the rated amperage.

26 12 16.04 Accessories

1. The following accessories are required on all transformers:
   a. Load rated rotary switch, externally operated 3 Pressure relief device
   b. Liquid level gage
   c. Top oil thermometer
   d. Cooling fans
   e. 1” drain with valve

26 12 16.05 Drawings, Specifications

1. Each quotation shall include the following data, and all data will be guaranteed:
   a. All outline dimensions including appurtenances.
   b. A drawing of the proposed nameplate (complete with all data available at the time of the quotation).
   c. Rating of the transformer in KVA.
   d. Exciting current at 100 and 110% of the rated voltage.
   e. Excitation losses in watts at 100 and 105% of the rated voltage and 25 degree C.
   f. Full load losses in watts at 100% of the rated current and 85 degree C.
   g. Efficiency at full load.
   h. Percentage regulation at 1.0 PF and 0.8 PF.
   i. Percentage "IZ" of the transformer.
   j. Weight of complete transformer (including oil).
   k. Gallons of oil.
   l. BIL rating.

26 12 16.06 Tests

1. The following certified tests and reports described herein shall be performed and documented with all test reports submitted to the ASU Electric shop within 30 days of shipment:
   a. Ratio Test - phase relationship.
   b. Polarity
c. Resistance  
d. Impedance voltage  
e. Full Load Loss  
f. Excitation Losses  
g. Core loss  
h. Exciting Current  
i. High Potential (where applicable)  
j. Induced Voltage  
k. Production Impulse Test  
l. ASU purchase order number and/or project number  
m. Serial Number  
n. KVA  
o. Voltage  
p. BIL  

2. A complete oil analysis shall be provided to establish a baseline.

26 12 16.07 Testing

1. Insulation test shall be applied to all feeders and sub feeders. Such test shall be made with a "megger" capable of ringing through 50,000 OHMS and with a maximum applied voltage of 500 volts. The grounding system will be tested as a complete network with the cable connection to the water mains disconnected. Test point for the Network is to be in the approximate center of the side structure. Test procedure to be used is the "Fall of Potential Method" according to IEEE standards. According to this test procedure, two test rods are driven at 62 ft. and 100 ft. from the installation. Readings shall be taken on the grounding system by a third party testing agency. The cost born by the contractor must notify ASU Electrical Services 72 hours before the test. Submit a written report to the engineer and ASU for records. No new services will be turned on until all these tests are completed and deemed satisfactory. No ground which has greater than 5 ohms to earth will be acceptable by ASU Electrical Services.

2. After the installation is complete, voltage and ampere readings shall be taken at the mains of each panel with all connected equipment energized. Any phase unbalance shown from these tests shall be corrected by the contractor. All circuits shall be checked to insure that each circuit is connected to the proper neutral. Insulation resistance shall comply with N.E.C. All transformers shall be UL listed and meet all requirements of the ASA and NEMA. Upon delivery of a transformer to ASU, a copy of the certified manufacturer's routine tests, as outlined and prescribed by NEMA Transformer Testing Reports, shall be presented to the ASU Electric Services. All the tests performed by the manufacturer shall include, but not be limited to, the following:

   a. Ratio test - Phase Relationship  
   b. Core Loss  
   c. Exciting Current  
   d. Impedance Volts  
   e. Load Loss  
   f. Applied Voltage (High Pot Test)  
   g. Induced Voltage
3. The completed unit assembly shall be energized and checked completely for operation before shipment.

26 13 00 Medium-Voltage Switchgear

1. All medium voltage distribution equipment shall be rated at 5,000 volts or 15,000 volts minimum based on system voltage.

2. All medium voltage switchgear (ACB's) shall be manufactured by Cutler Hammer or S&C (or equal), compatible with the ASU Central Plant distribution system. Sectionalizing switches shall be Cooper Vac-Pac, (all positions will be 600 amp rated; see Exhibit BB).

3. Connections to switches shall be by standardized apparatus connectors (well bushing, bushing and cable connectors) as manufactured by Elastimold, Cooper, Raychem.

4. Installation shall be in accordance with manufacturer's instructions. Each transformer's primary and secondary conductors shall be protected with fusing in all ungrounded lines using S&C or Cutler Hammer full height metal clad switchgear with S&C renewable fuses.

26 20 00 Low-Voltage Transformers

1. No transformers will be installed unless they are copper wound. Aluminum wound transformers are not acceptable.

26 24 00 Switchboards and Panelboards

26 24 00.01 General

1. Bussing of the switchboard should be of sufficient capacity to accommodate the next size larger transformer bank. Main breakers should be similarly sized.

2. Buss bracing and Short Circuit Rating shall be for the calculated fault currents. If a calculated fault current is not known, the bracing and rating shall be a minimum of 65,000 AIC amps on any switchboard or panelboard.

3. In each electrical distribution section shall be equipped with provisions for 25% additional space beyond that indicated in the schedules or on the single line diagrams for future use.

4. Feeder to switchboard may be wire in conduit or "buss way". Wires in conduit where multiple conductors per phase are required, must be precut so all conductors per phase are the same identical length after connection. Current capacity of "buss ways" and the size of conduit for conductors shall be such that the next size larger transformer bank can be accommodated.

5. Switchboards use as service entrance equipment (Main switchboards) shall be of dead front construction with the enclosure grounded. An interior ground buss and
terminals are to be provided along with a jumper to the system neutral. All switchboards shall have a main breaker.

6. Circuit breakers are to be used for protective devices including a main disconnect. Fuses will be avoided. Where fault currents warrant, current limiting devices are to be specified. All breakers are to be identified and a complete index provided.

7. Main switchboards shall be convertible unit type, dead-front, dead-rear, totally enclosed, with Cutler Hammer, Square D, circuit breakers, or equal, as determined by ASU Electrical Services. With copper bussing only.

8. All switchboards shall be tested by a third party to manufacturer and NETA specifications or supplied voltage plus one and a half time.

9. Switchboards shall have main disconnects. Switchboards shall have metering with LED or LCD display and indicate phase to phase and phase to neutral voltage, current and wattage. All phases shall be supplied with a current and voltage metering connection to meter. On voltages 480 volts and less, no external potential transformers on the metering system will be permitted.

10. Main switchboard supply feeders shall have a ground reference, with grounded conductor, back to the secondary side of the supply transformer.

26 24 13 Switchboards

Description: Freestanding sections 600-amp and greater for the distribution of power to large equipment and branch circuit panelboards.

1. Distribution sections are to be located in areas not generally open to the public. Main distribution sections are not to be located in areas of elevated temperatures or high humidity. Janitor rooms, utility closets for steam and water, air plenums, areas of elevated temperatures and humidity, areas of dust and locations exposed to the weather are to be avoided. Mechanical rooms that are cool, dry and dust free are satisfactory; a separate distribution section room is required.

2. All sections shall be placed on a four inch high concrete base. Close proximity to the transformer vault is highly desirable. No water pipes or other system pipes, ducts, shall be run over or within 3 feet of any switchboard or switchgear.

3. All switchboards and switchgear shall be front accessible with a main breaker or fused switch. Sections shall have Grounded deal fronts with front covers bolted to sectional frame to gain access to conductor and mounting devices.

4. Distribution Section shall have a short circuit rating equal to or greater than the available short circuit current at the sections point in the system. Distribution sections shall be labeled with a UL short circuit rating and shall be fully rated. Series ratings will not be allowed.

5. All loads and fault calculations are to be tabulated and indicated on the drawings as part of the panel schedules must be calculated not dependent on transformer let through.
26 24 16 Panelboards

1. All busses will be copper and must be located in the rear of the panelboard cabinet.

2. Interiors shall be completely factory assembled with bolt-on overcurrent devices. They shall be designed such that switching and protective devices can be replaced without disturbing adjacent units and without removing the main bus connectors.

3. Boxes shall be formed of galvanized metal, chemically cleaned, and breaks in galvanizing shall be painted with metallic aluminum paint. Minimum size shall be 20" wide by 5-3/4" deep unless noted otherwise. Trims and doors shall be chemically cleaned. Front door and trim shall be finished with ANSI #61 or 49 light gray paint for surface or semi-recessed mounting, and shall be finished with a prime coat for flush mounting.

4. Provide a zinc primer factory finish on the exposed trim of flush mounted panels in corridors, offices and other public spaces.

5. If the finish of the cabinet or front is damaged, scratched or marred during installation, and before acceptance of the work, the damaged surfaces shall be refinished on the job to the complete satisfaction of ASU Electrical Services.

6. Power panelboards shall be dead front, totally enclosed, convertible type Cutler Hammer, Square D, or approved equal and shall have a main breaker.

7. Panelboard covers shall be calculated hinged with piano style hinges. (Hinge on hinge or door on door.)

8. All panelboards shall have main breakers unless approved by ASU Electrical Services.

9. Panelboards shall not be series rated or feed through design.

10. All panelboards shall have a short circuit rating and AIC bracing that exceeds the calculated fault current at the point in the system that the panel is installed. Calculations shall be made and submitted to ASU CPMG A/E Electrical Engineer and Electrical Services and indicate possible fault current. Where no calculations were performed; panelboards less than 100 amp shall have a minimum of 10,000 AIC bracing. Panelboards over 100 amps shall have 22,000 AIC bracing. Panelboards 400 amp and over will have a minimum of 35,000 AIC bracing.

11. In each electrical distribution panel, the contractor will provide a minimum of 25% spare breakers and spaces. A minimum of six spare breakers and four spare spaces must be provided.

12. For flush mounted or other non-accessible panels, the contractor will provide one ¾ inch spare conduit for each three spare breakers and one spare conduit for each three spaces. In addition, the contractor will provide one spare one inch conduit for each 20 and/or fraction of 20 panel spaces counting all possible spaces in the panel.
13. For panels of 200 amp capacity and over the contractor will provide one two inch conduit for each multiple of 200 amps or fraction over 200 amps. Stub conduits into accessible attics, above accessible ceilings or in location directed by ASU Electrical Services.

14. All panels shall be labeled and a complete and accurate index provided inside the panel door. The index must be typed. This applies to remodeled areas as well. ASU room numbers shall also be indicated.

15. All outdoor lighting panels (i.e., tennis courts, stadium, etc.), shall have HI magnetic breakers square D type QO130 HM, or as approved by ASU Electrical Services.

16. All panels shall contain a ground buss.

17. All panelboards shall be keyed alike in each building, and attention must be given in this respect where new wings are added to existing buildings.

18. Where the load supplied by a panel requires separate isolated grounding, the isolated ground conductor shall be sized to match the equipment grounding conductor and installed with all other conductors from the main panel, or transformer directly feeding panelboard. A separate isolated ground buss shall be provided in the panel and labeled.

19. The contractor will provide a spare empty panel next to all new distribution panels for future use.

20. ASU Electrical Services will review and approve all panel designations to assure conformance to a reasonable campus ID system. In general, panel identification shall follow a general form as follows:

   a. "By room number:"
   b. M - main distribution panel
   c. E - emergency lighting and power panels
   d. L - lighting panels i.e., 277/480V
   e. P - power panels i.e., 120/208V

21. Combinations may be used such as:

   a. ML - main lighting panel
   b. MP - main power panel
   c. ME - main emergency panel
   d. MCC - Motor Control Center

22. Multiple panels are to be designated by room number sequence i.e., the first number to indicate the room, the following numbers are sequential letters, clockwise from entry door. Example: Panel L022B:

   a. Type L = Lighting Panel
   b. Floor 0 = Basement
   c. Room 22 = Room Number
   d. Location B = Second panel from left
23. Panels in corridors shall follow same sequence [i.e., L-C (0,1,2) (A,B,C...)].

**26 24 19 Motor Control Centers**

1. Starters should be grouped into motor control centers. Individual starters, except in isolated cases, are to be avoided.

2. Motor Control Center(s) shall be 600 volt class suitable for operation on a three phase, 60 Hertz system.

3. Motor Control Centers shall contain a main horizontal copper, silver-plated bus, with ampacity as required for the project, minimum 600 amperes. Vertical busses feeding units compartments shall be silver-plated copper and shall be securely bolted to the horizontal main bus. Joints shall be front accessible for ease of maintenance. The vertical bus shall be rated 50% of the main horizontal bus or 300 amperes, whichever is greater for front mounted units.

4. Busses shall be braced for 65,000 amperes RMS symmetrical at 480-volts.

5. A copper ground bus with a cross-section equal to at least 25% of the capacity of the main bus rating shall be bolted to sections and include terminal lugs.

6. The enclosure type shall be in accordance with NEMA Standards for Type12 with gasketed doors. Enclosing sheet steel, wireways and unit doors shall be gasketed.

7. Wiring shall be NEMA Class II, Type B.

8. Provide a separate source disconnect switch for each circuit brought into a starter or relay enclosure form a voltage source external to the starter.

9. Starter units shall be combination type, with components and wiring readily accessible for ease of maintenance, connected to vertical bus by self-aligning connectors having free floating spring construction to insure positive silver-to-silver contact with both sides of bus.

10. Thermal magnetic devices with solid state overload shall be provided to obtain specified short circuit rating.

11. Provide three solid state overload units sized for the 124% of the connected motor load.

12. External operating handle of circuit disconnect shall be interlocked with door so handle must be in “Off” position before door can be opened, handle arranged for padlock either in “On” or “Off” position, with from one to three padlocks. Provide units with automatic disconnecting terminal boards for ease of removing units without loosening terminal connections.

13. Each starter should have a hand-off-automatic (HOA) switch coordinated with the automation system.
14. All control power will be in the form of a control power transformer for each starter AND must originate within the cubical of the MCC such that the removal of the cubical or turning the cubical master switch off will remove voltage from the control circuit. Transformer will be sized 150% of full load current of control circuit and starter inrush. Control voltage shall not exceed 120 VAC.

15. Control and interlocks are to be coordinated with the automation system to maintain this requirement, with the exception of those systems controlled from the fire alarm panels for fan shutdown.

16. Starters are not to be sized with the largest dip switch selectable heater at the running current valve for the motor. Starter size must accommodate heaters 125% of the full running current of the motor. Heater elements shall be sized in accordance with the manufacturer's recommended size, based on the individual motor name plate rating or as recommended by the NEC.

17. Motor starters shall incorporate over current, over voltage, under voltage and phase lost motor protection. Starter using replaceable heaters shall not be used.

18. Coordination regarding motors, starter control, interlocks and automation controls is necessary.

19. Cross references to equipment lists and common equipment designations and identification is required on the drawings.

20. Motor controls in Central Plant and all new buildings designed to be connected to the Powernet energy management system shall have a low voltage release instead of HOA and shall have a keyed lock or facility for a padlock.

21. All motor control centers will have a monitor modular meter to display the total volt, amps and kilowatts with power factor and kilowatt hours. The unit will monitor and display each starter's volts, amps and cause of trip at the Motor Control Monitor and Powernet System.

22. All Motors 60 horsepower and above shall be soft-start or variable frequency drive (VFD) controls. All motors starters shall be specified and provided for in the appropriate section of Division 26 – Electrical, unless provided as an integral part of the manufacturer's package equipment. Starters shall conform as follows:

a. Three phase motors shall have full voltage magnetic across the line starters, unless a current limiting starter is specified. Thermal dip switch with selectable overload protection shall be provided on all three legs. Auxiliary contacts shall be provided as required for control interlocks.

b. Equipment starters with control transformers shall have fuse protection on the secondary side of the transformer.

c. Provide a start-stop membrane type push button switch in the control panel door except when an interlocking or automatic control device is needed, then Hand-Off-Automatic membrane type selector switch shall be provided in the panel door cover.

d. Red and green LED or LCD illuminated status lights shall be included (green shall indicate "run").
26 24 20 Motors

1. All motor installations must conform to the NEC requirements for control and protection. Motor starters and overload protective devices shall be provided for all motors 1/3 HP or larger. Plugs may be used as disconnects only on motors less than 1/3 HP, only as allowed by the NEC, and is recommended for all hot water circulating pumps.

2. Normally, motors up to 1/2 HP should be specified as 115 volt or 230 volt; single phase motors above 1/2 HP shall be 480 volt-three phase-60 cycle.

3. All 3-phase motors of 3/4 HP and larger shall be furnished with magnetic starters that provide overload protection. For single phase motors, under-voltage protection shall be required.

4. Motors of 1/2 HP and less shall have fractional horsepower manual motor starters, or have built-in motor protection. Consideration must be given for protection against weather where outside installations are called for.

5. Motor feeder conductors, larger than No. 10 AWG, shall have compression connectors bolted to motor leads at the motor.

6. Proper alignment of the motor to the equipment which it operates is essential.

7. Motors 5HP, 480 V, three phase and larger shall be controlled by the Central Plant Building Automation System (excluding, i.e., air compressors, condensate pumps and sewage ejector pumps).

8. All electric motors shall be induction type, 1750 RPM unless approved otherwise.

9. Motors shall have a minimum 1.15 service factor for continuous duty. 5 HP and smaller shall have factory sealed permanently lubricated ball bearings. All motors 5 HP and larger shall be premium efficiency type.

10. In all equipment with factory installed motor starters, the motor starter shall be order with circuit breakers in lieu of fuse if available as an accessory.

11. All motors five (5) horsepower and above shall be connected utilizing ring terminal (lugs) and the appropriate hardware (screw and nut or bolt and nut).

26 27 26 Wring Devices

1. Devices shall conform to NEMA standards, shall be UL listed and labeled, and shall be “Specification Grade” meeting the requirements of FS WC-596-F and switches meeting the requirements of FS WS-896-E.

2. Wiring devices exposed to outdoors or wet locations shall be installed in “FS” or “FD” series conduits with weatherproof cast metal covers, and gaskets as required.
26 27 26 .01 Receptacles

1. Duplex receptacles shall be U-ground, rated for 125 volts, 20 amperes back and side wired with a thermoplastic nylon body. Receptacles shall be equipped with a full length steel back plate (strap).

2. Duplex receptacles with ground fault interrupter characteristics shall be U-ground, rated for 125 volts, 20 amperes, Specification grade, feed-through type. Receptacles in bathrooms/toilets, within 6'-0" of a sink location, exterior outlets, utility vault, in set areas, and other locations shall be ground fault type.

3. Single receptacles feeding critical, or high amperage loads shall be twist-lock type with cord cap to match.

4. Approved manufacturer: Hubbell, Bryant, Arrow Hart, Pass & Seymour, or approved equivalent.

5. All cover plates shall match the color of the electrical device.

6. Where weatherproof mounting is required they shall be mounted in an FS box with Crouse - Hinds #DS 70 G cover, with gasketed spring type door for duplex receptacles, #DS10G for single receptacle, or Hubbell #5222 for duplex receptacles, Hubbell #5221 for single receptacle, Hubbell #7425 for power outlets, or approved equal.

7. Receptacles will be 20 amp min. rating, industrial specification grade back and side wired with a thermoplastic nylon cover and body. Receptacle cover plates will be labeled indicating feeder panel and breaker identification. Labels shall be on machine printed tape 1/4" wide clear with black letters. Contractor shall submit proposed labeling system to ASU Electrical Services for approval.

8. Armored cord grips and cord caps, where required, shall be provided for all special outlets in the amount of one cap for each special outlet.

9. Contractor shall submit specifications on cord caps to ASU Electrical Services for approval.

10. No convenience outlets shall be installed adjacent to water faucets or hydrants unless GFCI protected.

11. The elevation of each outlet must be specified or indicated on the drawings.

12. Receptacles and devices shall not be connected for feed through, but pigtailed in box for circuit continuation.

13. Tumbler switches shall be flush mounted wall type tumbler switches and shall be silent mechanical type rated at 20 amperes, 120/277 volts AC Industrial grade with back and sided wired and with a nylon toggle.

14. If more than one 20 amp circuit is installed in a conduit with a common neutral, size the neutral conductor shall be a #10 THW minimum.
15. Cover plates shall be stainless steel or .040" brass with brushed chrome finish as manufactured by Bryant, or as approved by ASU Electrical Services. All cover plates shall be marked to indicate the supply panel and circuit number. Use 1/4" wide clear tape with black lettering.

26 27 26 02 Switches

1. Switch locations for lights should be 48" above the floor, or as specified under ADA requirements. Cover plates for wall switches shall not be plastic. Stainless steel only, unless authorized by ASU Electrical Services.

26 28 13 Fuses

1. Fuses shall be rated for proper voltage in which they are applied. Interrupting ratings shall be greater than the short circuit current available at the load side of the fuse.

2. For motor, welder, transformers, capacitor banks (circuits with heavy inrush currents) type RK5 fuses shall be used. For all other types of loads type RK1 or type L fuses shall be used. For control circuit protection type CC (fast-acting) fuses shall be used.

3. Safety disconnect switches shall be furnished and installed as a disconnecting means for all motors and equipment as required by Code or this standard.

4. Safety disconnect switches shall be heavy duty, horsepower rated, quick-make, quick-break mechanism with visible blades, capable of switching 10 times the switch rating. Fuse pull out style will not be acceptable.

5. Switches shall have handle whose position is easily recognizable and is padlockable in the “OFF” position.

6. Switches shall be furnished with cover interlocks with defeat mechanism for maintenance; fused where required.

7. Switches shall be rated from 30 to 1200 amperes; 250 volts AC, DC; 600 volts AC; 2 or 3 pole; copper terminals; with manufacturer supplied ground bus.

8. Switch enclosures shall be Nema 1, general purpose where installed indoors; Nema 12; dust-tight and oil-tight in industrial areas and Nema 4X stainless steel where the disconnect switch is outdoors, or exposed to weather or in wet areas.

9. Each switch shall have a mechanically attached engraved nameplate. Engraved nameplate shall include equipment designation (abbreviation and full name), normal or emergency power, voltage, phase, amperes rating of upstream feeder device and upstream panel as follows:

<table>
<thead>
<tr>
<th>EX-1</th>
</tr>
</thead>
<tbody>
<tr>
<td>EXHAUST FAN #1</td>
</tr>
<tr>
<td>NORMAL POWER</td>
</tr>
</tbody>
</table>
26 28 23 Enclosed Circuit Breakers

1. Gutter mounted motor control components consisting of starters and fused switches are not considered desirable construction for a university building and must be approved by ASU Electrical Services.

1. Circuit protection should be in the form of circuit breakers mounted in suitable panels with ON, OFF, TRIPPED indication. Disconnect switches shall be used where necessary at remote motor locations. Motor starting controls shall be centralized in a single motor control center if a sufficient number is involved and shall have illuminated “stop” and “run” indicators.

2. Gutter mounted motor control center consisting of starters and fused switches are not considered desirable construction for a university building and must be approved by ASU Electrical Services.

3. Circuit protection should be in the form of circuit breakers mounted in suitable panels with ON, OFF, TRIPPED indication.

4. Disconnect switches shall be used where necessary at remote motor locations. Motor starting controls shall be centralized in a single motor control center if a sufficient number is involved and shall have illuminated “stop” and “run” indicators.

5. Control centers shall be Square D, Cutler Hammer or as approved by ASU Electrical Services.

6. Only those with copper bussing throughout will be acceptable, rated at 65,000 AIC fully braced. Starters shall be UL listed for 3 million operations or more, with LED or LCD membrane type pushbuttons with off, auto, speed and run indication. All starters shall have dip switch selectable heaters in lieu of thermal overloads with overload trip class selection.

7. All disconnects for starters shall have positive lockout in the "OFF" position.

8. Motor controls in Central Plant and all new buildings designed to be connected to the Powernet energy management system shall have a low voltage release instead of HOA and shall have a keyed lock or facility for a padlock.

9. All motor control centers will have a monitor modular meter to display the total volt, amps and kilowatts with power factor and kilowatt hours. The unit will monitor and display each starter's volts, amps and cause of trip at the Motor Control Monitor and Powernet System.

10. All Motors 60 horsepower and above shall be soft-start or variable frequency drive (VFD) controls.
11. All motors starters shall be specified and provided for in the appropriate section of Division 26 – Electrical, unless provided as an integral part of the manufacturer's package equipment. Starters shall conform as follows:

   a. Single phase motors shall have a manual starter with integral overload protection.
   b. Three phase motors shall have full voltage magnetic across the line starters, unless a current limiting starter is specified.
   c. Thermal dip switch with selectable overload protection shall be provided on all three legs.
   d. Auxiliary contacts shall be provided as required for control interlocks.
   e. Equipment starters with control transformers shall have fuse protection on the secondary side of the transformer.
   f. Provide a start-stop membrane type push button switch in the control panel door except when an interlocking or automatic control device is needed, then Hand-Off-Automatic membrane type selector switch shall be provided in the panel door cover.
   g. Red and green LED or LCD illuminated status lights shall be included (green shall indicate “run”).

**26 29 23 Variable Frequency Motor Controllers**

1. Variable Frequency Drives (VFD’S) shall have a microprocessor based control system, high frequency IGBT semi-conductors or better. Pulse width modulated system and voltage vector control devices is preferred to supply full rated motor voltage control at rated frequency. Full motor performance without derating, with high efficiency is needed for both drive and motor. A diode-bridge rectifier and DC line reactor or AC choke is recommended to provide a high displacement power factor at all speeds and loads and to provide a low percentage of power line harmonics. VFD’s shall have a minimum five year manufacturer’s warranty.

2. The VFD shall have a back light liquid crystal display with minimum 1/4 inch characters, to indicate the setup, operation and monitoring of drive to be displayed, such as volts, amp, speed, frequency kilowatts and kilowatt hours with run, local or remote control indication. Acceptable units are ABB Cutler Hammer, Gramham, or approved equivalent.

**26 29 23 01 Operating Parameters**

1. Hand/Start will start the drive (assuming safety interlocks are closed) with the speed of drive controlled manually via “+” and “-” buttons.
2. Off/Stop shuts down drive regardless of other commands.
3. Auto/Start - drive will start and stop the drive via external contact closure. The speed is controlled via the building automation signal (4-20 mA, 0-10 volt DC, etc.).
4. Program password to perform any change.

**26 29 23 02 Setup Applications**
1. Factory program and start up shall be provided with a minimum five year parts, labor warranty, including travel time. This should initiate from time of start up.

**26 29 23 03 Drive Features**

1. Current limit circuits shall be adjustable from 0-110% of the VFD's size factory default motor current.

2. Constant torque start to allow constant torque start to full torque of motor on acceleration until drive reaches set point.

3. Three phase output current measurement and software measures output on all three phases.

4. The phase to ground is instantly detected and has an adjustable trip.

5. The VFD shall have Integrated electronics, with thermal motor protection.

6. VFD shall calculate the motor temperature based on current, frequency and run time, and allows for changing cooling conditions as speed and load vary.

7. The VFD shall have a DC line reactor to filter and reduce harmonics reflected back into the building power system.

8. The VFD shall have voltage surge protection on the line side of drive.

9. Acceleration and deceleration shall be used to shape voltage and current curves and should automatically be contoured to prevent drive tripping.

10. The carrier frequency should employ IGBT’s for high switching frequencies to prevent audible motor noise and to insure that motor current is practically sinusoidal.

11. The VFD shall have critical frequency lockouts to avoid specific frequencies which cause mechanical resonance problems.

12. The VFD shall have Built-in communications for direct communication to Johnson Metasys (N2) Landis & Staefa System 600.

13. The voltage input for nominal + or - 10% adjustment should be from 200 through 240 volt range for 220 volt systems and 400 through 480 volt range for 440 volt three phase systems.

14. The VFD shall have three interlock contactor bypasses with an hmcp 65,000 AIC breaker to insure that the drive power is removed from the VFD bus.

15. A VFD drive lockable line safety selector switch to disconnect the VFD with a mechanical door interlock that is externally operable and can be locked out.

**26 50 00 Lighting**
26 50 00 01 Description

1. Exterior lighting must be for access and safety uses. Decorative lighting is to be avoided. Mall lights are to be of the campus standard type (12' high with cylindrical shroud head, fixture and shroud shall have an anodized bronze finish) with spacing at maximum (70') and lamp wattage at 175 watts, metal halide type. All exterior lights are to be controlled from Central Plant through a latching relay and lighting contactors. **Photo cells, clocks or time commanders are to be avoided**, unless approved by ASU Electrical Services.

26 50 00 02 Lighting Limitations

1. Arizona Revised Statues Title 44, chapter, (AR) Article 15, Section 1 & 2 places some limitations on outdoor lighting fixtures.
2. **THESE PROVISIONS WILL BE ENFORCED.**
3. No Mercury Vapor (MV) Outdoor lighting or L.P.S. (Low Pressure Sodium).
4. Interior lighting must be designed with energy conservation in mind.
5. Appropriate task lighting and light levels are listed in Section 26 05 10.
6. Light fixtures shall be in compliance with 1999 NEC Article 410.4 for wet locations especially around bathtubs and shower areas.

26 50 00 03 Lighting Intensities

1. For general illumination of building spaces, the lighting design shall be based on Section 26 06 10 and IES Lighting Hand Book latest edition.
2. It is suggested that general lighting be concentrated near chalkboards to give increased intensities on the chalkboards.
3. In making lighting calculations due allowances must be made for the reflectivity of walls, ceilings and floors.
4. Color schemes must be known before calculating design intensities.
5. Provide switches for all lights except minimal night safety lights and lights on emergency lighting system. Hall lights will be keyed switches. Occupancy sensors shall be incorporated.
6. Areas such as halls and large rooms with more than one exit should have three and four way switching.
7. All light fixtures must be readily accessible for relamping.
8. Fixtures in rooms that have obstructions such as lab tables or lecture furniture must not be higher than 12 feet above the floor or must have access from above for relamping.
9. In clear level area high bay lighting over 20 feet must have access from above or some means of lowering the lights to 12 feet.
10. Lighting accessible from above must have the appropriate catwalks, etc. to meet the requirements of ADOSH.
11. All machine room, fan plenums, utility area pipe and air tunnels should have adequate lighting so a person can work on the machinery or utilities without supplemental light.

12. Tunnels and fan plenums should have redundant lights so that one lamp failure will not completely darken the area. Light fixtures shall not be located above equipment or on high ceilings where re-lamping would be difficult. Circuits for these rooms and tunnels shall be from the emergency power panels and will be switched.

13. Fixtures in staircase and entrances are to be located such that re-lamping does not require tall ladders, scaffolds at angles of ladders exceeding ADOSH limitations. In general, fixtures should be installed with eight feet as a maximum.

14. Lights are in general expected to be fluorescent. Incandescent, HID and HPS lights are to be considered only in special applications. Other lights may be considered only after review with ASU Electrical Services.

15. Fluorescent (2) lamp fixtures shall be of the (4) foot T-8 3500 degree K (kelvin). Eight foot lamps and fixtures should be considered for special applications only.

16. Other fluorescent lamps such as "U" tubes, low wattage for sake of shape or appearance, circle tubes or special colors will not be used or accepted, and will be removed at the DP's expense.

17. Fixture schedules are to be placed on the electrical drawings and not in the specifications.

18. All fixtures are to have common stock ballasts that are manufactured for future design.

26 50 00 04 Lamps

1. Incandescent lamps shall be inside frosted type unless otherwise specified. (Incandescent lamps should be avoided where possible)

2. Fluorescent lamps shall be hot cathode, rapid-start or slimline standard cool white, and low mercury type.

3. Only on projects with existing lighting will 34 watt energy saving tubes be used where 40 watt tubes are specified, except in dimming or outdoor applications.

4. All lamps shall be new and operating at time of acceptance of the electrical work.

5. (No exceptions).

6. Approved manufacturers are General Electric, Sylvania, or Phillips.

7. Lamps shall be type FO32T8 and 3500 Kelvin in color, low mercury type at ASU at the Tempe Campus, and other campuses as directed by Capital Programs Management Group.

8. Lamps shall be type FO32T8 and 4100 Kelvin in color, low mercury type at ASU at the Polytechnic Campus.

26 50 00 05 Lamp Ballast
1. Fluorescent lamp ballasts shall be the high power factor series type, CBM and/or ETL approved, and shall contain thermal protection, CLASS P for inside use.

2. All ballasts shall be UL Listed (Class P) CSA certified and shall not exceed Class A ambient noise levels and shall have a classification of “Low Harmonics.” Input current Total Harmonic Distortion content shall be 10% or below (expressed in percentage of full light output current levels) throughout the dimming range.

3. Ballast shall have an average lamp current crest factor below 1.4.


5. Ballast shall withstand line transients as defined in ANSI/IEEE C62.41, category A.

6. Ballast shall have a power factor of 90% or above.

7. Ballast shall not contain Polychlorinated Biphenyls (PCBs).

8. Ballast shall meet the requirements of the Federal Communications Commission Rules and Regulations, Part 18, Class A.

9. All ballasts shall be internally protected.

10. Ballasts must be quiet operating and provisions must be established for removing and replacing any noisy ones.

11. The noise level shall not exceed 34db when measured six feet from installed fixture.

12. Specify premium construction ballasts for each type of fixture, by manufacturer, name, and catalog number. Energy saving electronic ballasts with 10% or less total harmonic distortion is required.

26 50 00 06 Lighting Fixtures

1. Lighting fixtures shall be (2) tube energy saving type, and double switched for energy conservation and selected by the Electrical Engineer on the basis of the intended use of each space and any instructions which may be given by the DP.

2. The fixture selection shall be checked and approved by ASU Facilities Management Electrical Services.

3. Fixtures should be easy to maintain and replacement shades available from open stock.

4. Where strip lighting is used, it is recommended that the rows be arranged parallel with any exposed ceiling beams.

5. Flush and recessed fixtures installed in furred ceilings shall be provided with junction boxes located at least one foot from fixtures.

6. Wiring from junction Box to fixture shall be high temp. wire, as recommended by N.E.C., shall not be less than 4 feet, and not more than 6 feet of flexible steel ¾" minimum conduit, but only in areas that are accessible from the space below ceiling. (The only Exceptions are UL listed Assemblies)

7. In concealed locations, junction boxes shall be integral with fixture.
8. Flush and recessed fixtures installed in concrete shall be wired with high temperature wire from the local control switch to the accessible junction box in the furred-ceiling area.

9. Fluorescent fixtures shall incorporate a grid, screen, panel or other device which will prevent the falling of any tube which may become dislodged.

10. All light fixture lens shall be acrylic plastic, minimum 0.125 inch thickness.

11. Fixtures must be adequately supported to resist gravity forces. Wire, rod or support member shall support fixture from structure. Fixtures shall be secured as required by IBC.

26 50 00 07 Corridor Lighting

1. Corridor lighting shall be on wired occupancy sensors to permit a person to enter the building at night and proceed through the building turning on lights ahead of themselves as they go.

Corridor lighting shall include a night light/emergency lighting circuit with a minimum of one lamp in each fixture, at each change of corridor direction. These lamps shall be connected to an emergency power source for buildings with emergency power panels.

26 51 00 Interior Lighting

26 51 00 01 Unfinished Areas

1. All unfinished areas are to have a minimum of two (2) footcandles per square foot.

2. All future finished space shall have power capacity and breaker space provided in the feeder panels and distribution panels.

3. Telephone, automation and other signal raceways, including fire alarms serving unfinished but finishable areas, are to be complete through other finished areas.

4. Attics and other spaces not finishable are not required to have these raceways except for the fire alarm system.

5. Lighting in attics and service chases, etc. shall be provided.

6. Switches are to be located at each access using three and four way switching where two or more accesses exist.

7. All fixtures must be easily re-lamped, particularly in attics and mechanical chases without the use of ladders, hoists or scaffolds or catwalks must be installed.

2. 26 52 00 Emergency Lighting

1. Emergency lighting systems shall be installed wherever required for reasons of personnel safety and per code.

2. Review each installation with ASU Electrical Services on availability of emergency power from central plant. See Section 26 13 00.1 Items g & h.
3. At ASU at the Tempe campus, emergency lighting systems shall be separate from normal lighting panels, but feed will be from normal power through transfer switching and backed up by central plant emergency distribution system. See Section 26 13 00..1, Items g & h.

4. ASU at the Polytechnic campus has no emergency power system. Emergency existing lighting shall be designed utilizing a central emergency lighting inverter. Emergency lighting containing its own battery is unacceptable. Self powered exit lights need approval from Capital Programs Management Group.

5. **Do not use** battery operated exit lights or signs, or fluorescent battery DAC's for space lighting at the ASU at the Tempe campus.

6. All exit lights and signs shall be on the emergency lighting system.

7. Use long life LED lamps in all exit lights. Fixture shall have a cast iron housing.

8. Exit signs shall be internally illuminated with red LED letters and a stencil face. Directional arrows shall be distinct and below the letters i.e. not triangles or mixed in the lettering.

9. Battery operated emergency lighting may be used in small or special structures, that are not on the emergency grid, and with prior approval from ASU Electrical Services.

10. All raceways for the emergency lighting systems shall be separate from all other raceway conductors.

11. All central Emergency distribution panels shall be located such that they are accessible to qualified personnel only, such as in a mechanical room or electric switchboard room. Placement in janitor closets, halls, offices, classrooms, laboratories, storage rooms and closets is not acceptable.

12. A minimum of 50 footcandles of lighting shall be provided in electrical vaults and at the main switchboards and motor control centers.

13. Both normal circuits and emergency circuits shall be provided in a redundant fashion.

14. A dedicated 120 volt duplex outlet, rated at 20 amps, and on the emergency system shall be provided near the main switchboard and in the transformer vault along with normal circuits.

15. Emergency lights are not to be switched, except in equipment rooms, tunnels, and vaults. Circuits are to be connected to the emergency panel board direct, with above exceptions.

16. All emergency lighting circuits and lighting control diagrams are to be shown on the drawings.
DIVISION 28 – ELECTRONIC SAFETY AND SECURITY

28 20 00 SECURITY ACCESS AND SURVEILLANCE

Description

During the initial phases of the project, the DP, along with the DPM, representatives from the User group, ASU Department of Public Safety (DPS), and the ASU Lock Shop(s), shall assess the security needs of the project. Discussion shall include the project specific system, maintenance and service responsibilities of the individual system, and the system's interface with the owner's Central Reporting system to ASU DPS (where applicable). It should be noted that Call Center Services are becoming more common to “triage” for DPS.

This standard applies to door access, alarms and surveillance systems. All buildings will include an electronic door access system at all entries from the exterior, and for all laboratories as a minimum.

The Risk Assessment Checklist will be completed for all laboratories and will be used to determine the minimum security hardware for each of the laboratories. The Checklist is available from the DPM.

Programming

ISAAC may be used to control access at all exterior (zone) doors and at certain interior access control zones, such as specialty labs, computer labs, some office suites, some audio/visual equipment rooms, and other zones with specific access concerns.

To facilitate the implementation of ISAAC, certain programming issues need consideration during design. These include:

- Physical separation between public/non-public areas.
- Physical separation between different departments/operating units in the same building.
- Access during periods of time on weekends and after hours
- Conflicts between access control and life safety, i.e., egress, latching of fire doors.
- Conflicts between access control and ADA accessibility
- Minimum levels of security to be afforded to Specialty Laboratories

At a minimum, all exterior zone openings (doors) shall receive rough-in for ISAAC installation based on requirements determined during project Programming and Schematic phases.

The owner's vendors furnish and install some ISAAC equipment and wiring. Other equipment shall be by Contractor. The status of this equipment shall be determined during program conferencing.
Design Standards

A. Risk Assessment Checklist: The risk assessment checklist, ASU form shall be used to discover and document the minimum level of security options for each laboratory. This assessment shall be initiated by the project coordinator and completed by the assessment team.

B. Basic ISAAC Systems Architecture

The following diagram shows the major ISAAC components and how they are connected to each other. There is a separate diagram that provides more detail on the ISAAC and hardware wiring that is involved.

Architecture Diagram Notes – The architecture diagram depicts the way that major ISAAC components work together at ASU:

a. A secure server room contains the ISAAC database & applications server and the TSISSAC server, which runs MS terminal server and the Lenel client software. These servers are on a LAN that is connected to the campus WAN behind a firewall.
b. ISAAC administrators, such as Segment Administrators, access the ISAAC database by using MS Remote Desktop to log in to TSISAAC. Once in, they log in to the Lenel client software that is running on TSISAAC. The number of clients that can be simultaneously be logged in to ISAAC is limited by the number of Lenel clients licensed and installed on TSISAAC. User computers may be connected directly to the campus WAN, or may access the campus WAN remotely through a public connection. User computers must be running SecuRemote.

c. A private ISAAC VLAN connects the ISAAC hardware (Intelligent System Controllers, DVR's, IP cameras) to the secure server room LAN.

d. There is at least one Intelligent System Controller (ISC) in each building connected to the ISAAC VLAN. Card readers are connected to the ISC’s – up to 64 readers per ISC.

e. A Digital Video Recorder (DVR) server can also be connected to the ISAAC VLAN. Up to 32 cameras can be connected to each DVR via COAX and power lines.

C. ISAAC Database and Segments –

a. Software Standard: LENEL Software shall be “PRO” level standard or (better?)

b. Hardware Standard: HID I Class Smart Card and Smart Card Readers. All interfaces will have to be compatible with the (insert here)

c. ISAAC has a single shared cardholder database that contains information on all current faculty, staff, students, and those ASU affiliates who have an ASURITE userID.

d. ISAAC has a segmented database for information about readers and access controllers, schedules, permissions and relationships.

Note: Segmentation is the means used to allow a unit or group of units to control the spaces for which they are responsible – a segment is created for an area or set of areas that will be separately managed. There are ISAAC segments for some campuses, some colleges, some research group, for Lock Shop-managed areas, and so forth. Each segment name identifies the unit or group that has overall responsibility for its management. Information created and maintained in one segment is not visible from any other segment, although the overall ISAAC system administrators can see and deal with information in all segments.

e. Reader interface units cannot be split among segments, so readers that are physically connected (wired) to a particular reader interface unit must be all in the same segment. This might occasionally mean that there is a need to install more reader interface units than would be required in a non-segmented database, or to require a reader from one reader interface unit to another when responsibilities change.
D. ISAAC Installation Planning – The **ISAAC Systems Administrator Procedure** document can provide additional procedural guidance to assist those who are responsible for major projects that will include installation of electronic access control. Following this design standard and the ISAAC specifications will help maximize efficiency installation of ISAAC. However, it is still best to coordinate projects with the Security Systems Sub Contractor from the design stage.

E. ISAAC Typical Hardware Diagram

The following diagram shows the ISAAC server and remote client PCs connected to the WAN.

Note: Diagram Courtesy of Henry Brothers Electronics

a. The remote client PC’s connect via TSISAAC. Also connected to the WAN is a box labeled: ISC (intelligent system controller), network interface, reader interfaces, and power distribution.
Connected to the ISC box are:

i. A 12 V and 24V Power Supply (PS) battery. These are connected to 120V AC.

ii. Doors with electric lock, electric strike, magnetic lock or electrified panic bar. Each door has a junction box or local power supply over it and each junction box or local power supply is connected to the ISC controller complex. Each junction box is also wired to a card reader next to the door. Typical wiring for each door is: 1 – 22/6 (one 22 guage/6conductor), 1- 18/4, 1-22/4.

iii. The doors with the electric lock and the electrified panic bar show wiring through the door, through the transfer hinge, to the junction box or, in the case of the door with the electrified panic bar, to the local power supply. The door with the electric lock also shows a door position sensor (DPS) at the top that is wired to the junction box.

iv. The doors with the electric strike and the magnetic lock have request to exit (REX) over the door.

b. Each building needs at least one ISC (Intelligent System Controller).

c. Each Segment in a building needs its own ISC.

d. One Ethernet connection is required for each ISC.

e. An ISC can support up to 64 dual or 32 single reader interfaces

f. At least one power supply and reader interface location is required per floor.

g. Equipment locations require 120 VAC connections.

h. Door with electrified panic hardware require a local power supply with a 120 VAC connection. Battery back up is optional.

i. All other lock hardware is powered by a 24 VDC located in the equipment locations with battery back up.

j. There is one pair data line between the ISC and the equipment on each floor.

F. Surveillance Systems – Digital Video Recorders (DVR, Video Surveillance Systems etc...)

a. A private ISAAC VLAN connects the ISAAC hardware (Intelligent System Controllers, DVR’s, IP cameras) to the secure server room LAN.

b. There is at least one Intelligent System Controller (ISC) in each building connected to the ISAAC VLAN. Card readers are connected to the ISC’s – up to 64 readers per ISC.

c. A Digital Video Recorder (DVR) server can also be connected to the ISAAC VLAN. Up to 32 cameras can be connected to each DVR via COAX and power lines.

d. All video surveillance systems will be compliant to DPS Policy 201–06:
Governing Electronic Safety and Security Systems

G. Alarms and Alarm Monitoring

It is the responsibility of Capital Programs Management Group to ensure the ASU Department of Public Safety Crime Prevention representative reviews the security design.

Discussion shall include the project specific system, maintenance and service responsibilities of the individual system, and the system’s interface with the owner's Central Reporting system to DPS (where applicable). It should be noted that Call Center Services are becoming more common to “triage” for DPS.

H. Door Hardware – Install Adams-Rite Indoor Electric Strike Model 7140-510-628-00 24 VDC (or equivalent – voltage is most important) in the door frame in place of a normal strike. This usually requires cutting the frame to make it fit. A power source above the door is not necessary except for electrified crash bars – but avoid electrified crash bars if at all possible.

I. Conduit and Electrical Specifications – Install ¾” conduit to an electrical duplex box in the wall next to the strike at ADA height, within a foot or so. Include a pull string. The duplex box should be roughly level with the strike. Conduit should extend to above the ceiling to a point where we can get at it to run wire into it. Drill a hole from behind the strike to the electric box to run the strike wires.

J. Handicap Door Requirements - If the door has a handicap opener on it with a motor unit mounted above the door, be sure there is a ¾ inch conduit path from above the ceiling to the motor unit.

K. Communications Closet

   a. There shall be at least one dedicated closet for the location of ISAACS related equipment. In multi-story buildings where ISAAC equipment is located above grade, there shall be a closet on each floor where ISAAC controlled doors are located.

   b. Identify and reserve an area of about 7 feet wide, floor to ceiling in a communications closet (IDF room) on each floor. Normally, doing this will require coordination with Information Technology. Mount ¾ inch plywood as backing board, if it is not already there. Allow a 3-foot clearance in front of the identified area for door swing.

   c. Install a 4-plex power on its own circuit into each IDF of each floor in the identified area, running the conduit down the right or left side boundary edge of the area. In other words, don’t run the power down the middle of the area where we have to mount the equipment.

   d. If magnetic locks are used such that there are no crash bars, include a relay contact in the applicable data closet that closes when the fire alarm goes off so the mag-lock doors can be unlocked. The relay should provide both open and closed contacts.
e. Select one floor, usually centrally located, to mount the primary intelligent controller(s) (64 doors each) and run one standard ASU Ethernet network connection to this location. IT Data Communications will configure this port to operate on the security VLAN: all communication between ISAAC system controllers and the ISAAC host will be on a VLAN.

L. Wiring Requirements – Run two of each of the wiring types Belden 88760 and 9536 from the floor IDF to each door. This allows for extra needs such as door contacts or input sensors.

M. Cabling Installation

a. All cabling shall be plenum and UL listed.
b. All wall and floor penetrations shall be sleeved and fire stopped.
c. All cabling shall be self supported with J-Hooks either from the wall or with self supported hanger wire.
d. All vertical and horizontal pathways shall be 12 inches away from any voice/data cabling.
e. Existing voice/data pathways will not be utilized for security door cabling.
f. If the system controller is installed within a telecommunication room the space will be pre-approved with ASU Information Technology.
g. The system controller location(s) will be denoted on the floor plan and will be mounted in a locked cabinet.
h. The ASU Ethernet connection or connections required for the individual security system will be denoted on the floor plans.

N. Electrified Locks

a. The A/E shall review all technical requirements of the proposed system with ASU DPS and ASU Electric Shop prior to design development.
b. D-Series locks are available for electrically locking and unlocking controls for high security and fire safety applications. They are UL Listed and rated for both fire and electrical single point locking on labeled doors. Refer to the lock function pages for functions and design availability.
c. Electrical Requirements: 24V AC, .35 amps or 24V DC, .15 amps.
d. Operating Temperature: Maximum +151 1/2F, Minimum -31 1/2F
O. Latches & Strikes

a. Adjustable brass or bronze latch faceplates and strikes, furnished in compatible lock trim finishes.

b. Latch Bolt: Steel, ½" (12 mm) throw, deadlocking on keyed and exterior functions. ¾" (19 mm) throw anti-friction latch available for pairs of fire doors.

c. Strikes: ANSI curved lip strike 1 ¼" x 4 7/8" (32 mm x 124 mm), 1 3/16" (30 mm) to center standard. Optional strikes, lip lengths and ANSI strike box available.

E. Standard Features for Lock housing

a. Cylindrical lock housing. Cold rolled steel, corrosion treated for normal atmospheric conditions

b. Key removable outside knobs for easy cylinder replacement

c. Solid brass 6-pin cylinders

d. No exposed mounting screws

e. Exceeds 800,000 cycle ANSI Grade 1 requirements by nearly 4 times (3,000,000 cycles)
Diagrams:
A – Typical Lock Installation of Door – Need Updated THIS IS ONLY AN EXAMPLE

Typical Card Reader Controlled Single Door
1.1.1 Summary - General

Drawings and conditions of the contract, including but not limited to General Conditions, and the Special Conditions listed below, apply to work of this section.

- Supplementary Instructions to Bidders.
- Supplementary Conditions.
- Summary of the Work.
- Project Coordination.
- Cutting and Patching.
- Definitions and Standards.
- Submittals.
- Schedules and Reports.
- Temporary Facilities.
- Security Regulations.
- Safety and Health.
- Products.
- Project Closeout.

PROJECT/WORK IDENTIFICATION

Project Name and Location: (ASU BUILDING NAME)
Owners Representative for this project is: (ASU PROJECT MANAGER)
Contract documents indicate the work of contract, and related requirements and conditions that have an impact on the project. Related requirements and conditions that are indicated on the contract documents include, but are not necessarily limited to, the following existing site conditions and restrictions.

1.1.2 Summary - Fire

This performance specification provides the minimum requirements for the Life Safety System. The system shall include, but not be limited to all equipment, materials, labor, documentation and services necessary to furnish and install a complete, operational system to include but not limited to the following functions:

- Smoke and fire detection.
- Audible and Visible Notification.
- Campus Network Communication.

1.1.3 Project Representatives

All contacts with (Project Name) shall be directed to the Owner's Representative, hereafter referred to as the Owner: (ASU Project Manager)
1.2 References

1.2.1 General - Codes

All work and materials shall conform to all applicable Federal, State, local codes and regulations governing the installation including ASU Standards and Design Specifications. If there is a conflict between the referenced standards, federal, state or local codes, and this design specification, it is the bidder's responsibility to immediately bring the conflict to the attention of the Engineer, and Capital Programs Management Group for resolution. System components proposed in this specification shall be UL listed to operate together as a system. The supplier shall provide evidence, with his submittal, of listings of all proposed equipment and combinations of equipment. The supplier shall be responsible for filing of all documents, and securing all permits, inspections and approvals. Upon receipt of approved drawings from the authority having jurisdiction, the supplier shall immediately forward three sets of Fire Marshal stamped drawings to the Owner.

1.2.2 ASU Electrical Services

Any alteration to existing fire alarm systems shall be verified, in writing, by the ASU fire alarm technician before the start of work.

1.2.3 Codes - Fire

The equipment and installation shall comply with the current provisions of the following codes and standards:

- NFPA 70 - 2002 National Electric Code®
- NFPA 90A - 1999 Air Conditioning Systems
- UL 864 - Control Units for Fire Protective Signaling Systems.
- UL 268A - Smoke Detectors for Duct Applications.
- UL 464 - Audible Signaling Appliances.
- UL 38 - Manually Actuated Signaling Boxes for Use with Fire-Protective Signaling Systems
- UL 1971 - Signaling Devices for the Hearing-Impaired.
- UL 1481 - Power Supplies for Fire Protective Signaling Systems.
- Office of the State Fire Marshal
- Americans with Disabilities Act (ADA)
- ASU Fire Alarm Systems and Design Standards

1.3 System Description

1.3.1 General - Fire

The Contractor shall furnish all labor, services and materials necessary to furnish and install a complete, functional fire alarm system. The System shall comply in respects with all pertinent codes, building permits, design specifications, rules, regulations and laws of the Authority Having Jurisdiction. The System shall comply in all respects
with the requirements of the design specifications, manufacturer's recommendations and Underwriters Laboratories Inc. (UL) listings.

It is further intended that upon completion of this work, the Owner be provided with:

- Complete information and drawings (As-Builts) describing and depicting the entire system as installed, including all information necessary for maintaining, troubleshooting, and/or expanding the system at a future date.
- Complete documentation of system testing including air balance testing.
- Certification that the entire system has been inspected and tested, is installed entirely in accordance with the applicable codes, design standards, manufacturer's recommendations, and ULI listings, and is in proper working order. Contractor shall use "Fire Alarm System Certification and Description" as required by Section 1-6.2 of NFPA 72 - 1999 edition.

1.3.2 Description – Fire

Provide and install new fire detection and alarm system consisting of:

- Manual pull stations shall be located as shown on the drawings.
- Area smoke detection shall be provided as shown on drawings.
- Area heat detection shall be provided as shown on drawings.
- Beam smoke detection shall be located as shown on the drawings.
- Duct smoke detection shall be provided as shown on the drawings, and provide individual fan shutdown controls as shown on drawings.
- Provide audible appliances located throughout the building, as shown on the drawings and provide synchronized visual appliances located throughout the building, as shown on the drawings.
- Provide supervised monitoring of sprinkler tamper and waterflow devices as shown on drawings.
- Provide primary and alternate elevator recall with the ability to auto-reset elevator upon FACP reset.
- Provide connection to the Campus fiber optic network. ASU shall be responsible for bringing new fiber into the tunnel serving the building at the ASU at the Tempe campus including LIU and terminations. Contractor shall be responsible for conduit from the Network FACP, to the LIU, thru to the nearest active network connection.

1.3.3 Operations – Sequence of Operations

1.3.3.1 General - Audio

Upon alarm activation of any area smoke detector, heat detector, manual pull station, or waterflow monitor the following functions shall automatically occur:

- The internal audible device shall sound at the control panel.
- The LCD Display shall indicate all applicable information associated
with the alarm condition including: address, device type, device location and time/date.
- Any remote or local annunciator LCD/LED’s associated with the alarm zone shall be illuminated.
- Activate audible horns and visual strobes throughout the building.
- Transmit signal to the fire alarm network workstations with point identification.

1.3.3.2 Duct Smoke Activation - Supervisory

The supervisory activation of any single duct smoke detector, the following functions shall automatically occur:

- The internal audible device shall sound at the control panel or command center.
- The LCD display shall indicate all applicable information associated with the supervisory condition including; address, device type, device location and time/date.
- Any remote or local annunciator LED’s associated with the alarm zone shall be illuminated.
- Transmit signal to the fire alarm network workstations with point identification.
- Shutdown the local air handling unit only.
- Note: The activation of two (2) or more Duct Detectors shall put the fire system into alarm and shutdown all AHU’s, as indicated on the Sequence of Operations Matrix.

1.3.3.3 Trouble Operation

Upon activation of a trouble condition or signal from any device on the system, the following functions shall automatically occur:

- The internal audible device shall sound at the control panel or command center.
- The LCD keypad display shall indicate all applicable information associated with the trouble condition including; address, device type, device location and time/date.
- Transmit signal to the Network Fireworks workstations with point identification.
# ASU - FIRE ALARM SEQUENCE OF OPERATIONS MATRIX

<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td>Sprinkler - All types - Also includes other suppression systems</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Water Flow/Activation</td>
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<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Tamper/System Trouble</td>
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<td>X</td>
<td>X</td>
<td>X</td>
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</tr>
<tr>
<td>Smoke Detector</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>First Duct Smoke Detector in Alarm Condition</td>
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<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Second Duct Smoke Detector in Alarm Condition</td>
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<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>First Duct Type Smoke Detector for SFD operation in Alarm Condition</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Second Duct Type Smoke Detector for SFD operation in Alarm Condition</td>
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<td>X</td>
<td>X</td>
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<tr>
<td>Area Detector Used for SFD operation</td>
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<td>X</td>
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</tr>
<tr>
<td>Heat Detector</td>
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<tr>
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<tr>
<td>Elevator Equipment Room Smoke Detector</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Elevator Shaft Smoke Detector</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Elevator Equipment Room Heat Detector</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Elevator Shaft Heat Detector</td>
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</tr>
</tbody>
</table>

This Sequence of Operations Matrix is intended to be a standard for ASU buildings such as classroom, office, recreation and library facilities. ASU realizes that specialty use buildings, such as laboratory and research facilities will require special needs and will be reviewed on an individual basis. If there are additional control functions required, they can be added on an individual basis.
1.3.4 System Configuration

1.3.4.1 General

All Life Safety System equipment shall be arranged and programmed to provide the early detection of fire, the notification of building occupants, and the activation of other auxiliary systems to inhibit the spread of smoke and fire, and to facilitate the safe evacuation of building occupants. Smoke Verification (5 seconds) Programming shall be utilized whenever possible to reduce the occurrence of “false alarms”. Any one alarm will disable smoke verification.

1.3.4.2 Secondary Power Supply

Standby power supply shall be an electrical battery with capacity to operate the system under maximum supervisory load for sixty (60) hours and capable of operating the system for fifteen (15) minutes of evacuation alarm on all devices, operating at maximum load. The system shall include a charging circuit to automatically maintain the electrical charge of the battery and supervise the integrity of the battery. The system shall automatically adjust the charging rate of the battery to compensate for temperature. All system power supplies shall be capable of recharging their associated batteries, from a fully discharged condition to a capacity sufficient to allow the system to perform consistent with the requirements of this section, in 48 hours maximum.

1.3.4.3 Display

The main display interface shall show the first and most recent highest priority system events without any operator intervention. All system events shall be directed to one of four message queues. Messages of different types shall never intermix to eliminate operator confusion. A "Details" switch shall provide additional information about any device highlighted by the operator. Provide passcode protected manual by-pass switches for the following:

- AHU Shutdown by-pass
- Elevator Recall/Shunt Trip by-pass
- Horn/strobe by-pass
- Magnetic Door Holder circuit by-pass
- Smoke Damper by-pass
- Waterflow by-pass

1.3.4.4 Initiating Device Circuits

Initiating device circuits monitoring manual fire alarm stations, smoke and heat detectors, shall be Class A, and will use #16 AWG (unshielded)/STP/FPL solid copper wiring and shall be installed in a minimum ¾” red EMT conduit, and a min 2 1/8” deep 4 square boxes.
1.3.4.5 Notification Appliance Circuits

All notification appliance circuits shall be Class A, and will use a minimum #14 AWG stranded copper wiring and shall be installed in a minimum ¾” red EMT conduit, and a min 2 1/8” deep 4 square boxes. All notification appliance circuits shall have a minimum circuit output rating of: 2 amps @ 24 vdc. The notification circuits shall be power limited.

1.3.4.6 Signaling Line Circuits

The signaling line circuit connecting network panels and command centers shall be Class A. The media shall be a (6) strand, 62.5/125 multi-mode armored fiber optic cable, Systimax #370-063-DSX-06 or equivalent.

The signaling line circuit connecting to addressable/analog devices including, detectors, monitor modules, control modules, isolation modules, and notification circuit modules shall be Class A.

1.3.4.7 Network Wiring

The system supplied under this specification shall utilize node to node, direct wired multi-priority peer-to-peer network operations. The system shall utilize independently addressed, smoke detectors, heat detectors and input/output modules as described in this specification. Each node is an equal, active functional node of the network, which is capable of making all local decisions and generating network tasks to other nodes in the event of node failure or communications failure between nodes.

1.3.4.8 Network Nodes

The remote control panel (network node) shall meet the same requirements as described in control panel section and shall contain the following:

- Integral power supply with secondary stand-by power.
- Signaling line circuits for communications with analog/addressable devices, as required.
- Notification appliance circuits, as required.

1.4 Submittals

1.4.1 Project

The contractor shall purchase no equipment for the system specified herein until the owner and engineer has approved the project submittals in their entirety and has returned them to the contractor. It is the responsibility of the contractor to meet the entire intent and functional performance detailed in these specifications. Approved submittals shall only allow the contractor to proceed with the installation and shall not be construed to mean that the contractor has satisfied the requirements of these specifications. The contractor shall submit six (6) complete sets of documentation within 30 calendar days after award of purchase order.

Each submittal shall include a cover letter providing a list of each variation that the submittal may have from the requirements of the contract documents. In addition the
Contractor shall provide specific notation on each shop drawing, sample, catalog cut, data sheet, installation manual, etc. submitted for review and approval, of each such variation.

All drawings and diagrams shall include the contractor's title block, complete with drawing title, contractor's name, address, date including revisions, and preparer's and reviewer's initials.

1.4.2 Product Data

Data sheets with the printed logo or trademark of the manufacturer for all equipment. Indicated in the documentation will be the type, size, rating, style, and catalog number for all items proposed to meet the system performance detailed in this specification. The proposed equipment shall be subject to the approval of ASU and the Engineer.

1.4.3 Shop Drawings

A complete set of shop drawings shall be supplied. The shop drawings shall be reproduced electronically in digital format. This package shall include but not be limited to:

- Detailed system operational description. Any Specification differences and deviations shall be clearly noted and marked.
- Complete system bill of material.
- All drawings shall be reviewed and signed off by an individual having a minimum of a NICET IV certification in fire protection engineering technology, subfield of fire alarm systems.

1.4.4 Quality Assurance / Control Submittals

1.4.4.1 Installer's Certification

The engineered systems distributor must be licensed in the State of Arizona and have been incorporated in the business in that state for a minimum of 5 years.

Submit a copy of the system supplier's training certification issued by the manufacturer of the integrated life safety system, and a copy of the installing technician's NICET certification.

1.4.4.2 System Calculations

Complete calculations shall be provided which show the electrical load on the following system components:

- Each system power supply, including stand alone booster supplies.
- Each standby power supply (batteries).
- Each notification appliance circuit.
- Each auxiliary control circuit that draws power from any system power supply.
1.4.4.3 Close Out

Three (3) copies of the following documents shall be delivered to the building owner’s representative at the time of system acceptance. The close out submittals shall include:

- Project specific operating manuals covering the installed integrated life safety system. The manual shall contain a detailed narrative description of the system architecture, inputs, notification signaling, auxiliary functions, annunciation, and sequence of operations, expansion capability, application considerations and limitations. Manufacturer's data sheets and installation manuals/instructions for all equipment supplied. A generic or typical owner's instruction and operation manual shall not be acceptable to fulfill this requirement.
- As-Built drawings consisting of: a scaled plan of each building showing the placement of each individual item of the Integrated Fire Alarm System equipment as well as raceway size and routing, junction boxes, and conductor size, quantity, and color in each raceway. All drawings must reflect point to point wiring, device address and programmed characteristics as verified in the presence of the engineer and/or ASU fire inspectors unless device addressing is electronically generated, and automatically graphically self-documented by the system.
- All drawings shall be provided in standard .DXF format. A vellum plot of each sheet shall also be provided.
- The application program listing for the system as installed at the time of acceptance by the building owner and/or local AHJ (disk, hard copy printout, and all required passwords).
- Provide the name, address and telephone of the authorized factory representative.
- A filled out Record of Completion similar to NFPA 72, 1999 edition figure 1-6.2.1.
- And provide final Building Permit signed off.

1.5 Quality Assurance

1.5.1 Qualifications of Contractor - Fire

The contractor shall have successfully installed similar system fire detection, evacuation and visual signaling control components on a previous project of comparable size and complexity. Installing contractor shall have completed installation of a minimum of 6 addressable network fire alarm systems. Contractor shall furnish project names and phone numbers of building owners if requested by this owner to qualify for bidding on this project.

The contractor shall have in-house project management capability consistent with the requirements of this project. Qualified and approved representatives of the system manufacturer shall perform the detailed engineering design of central and
remote control equipment. Qualified and approved representatives of the system manufacturer shall produce all panel and equipment drawings and submittals, operating manuals. The contractor is responsible for retaining qualified and approved representative of those system manufacturers specified for detailed system design and documentation, coordination of system installation requirements, and final system testing and commissioning in accordance with these specifications.

1.5.2 Pre-installation Meetings - Requirements

The provider shall submit a detailed project plan that will describe in detail how the provider will approach the project, from inception to finalization. The plan must include at a minimum the following information:

- Project Staging
- Project Management
- Final Acceptance Testing

All equipment and components shall be installed in strict compliance with each manufacturer's recommendations. Consult the manufacturer's installation manuals for all wiring diagrams, schematics, physical equipment sizes, etc. before beginning system installation. Refer to the manufacturer’s riser/connection diagram and details for all specific system installation/termination/wiring data.

1.6 Project Conditions

It shall be the Contractor's responsibility to inspect the job site and become familiar with the conditions under which the work will be performed. Inspection of the building will be made as part of the pre-bid meeting.

A pre-bid meeting will be held to familiarize the Contractors with the project. Failure to attend the pre-bid meeting may be considered cause for rejection of the Contractor's bid. The minutes of this meeting will be distributed to all attendees and shall constitute an addendum to these specifications.

All work may be [unless otherwise noted] conducted during normal working hours, 8:00 a.m. to 5:00 p.m., Monday through Friday, by properly coordinating the work with Capital Programs Management Group. Noise restrictions do apply! The core drilling, testing of evacuation signals and other work disruptive to occupants will be prohibited between 6:00 a.m. and 6:00 p.m., Monday through Friday, and will be explained at the pre-bid meeting. Contractor is to include, in his base bid, all overtime necessary to complete his work. The Contractor shall be responsible for prior coordination of all work, demolition, and asbestos abatement with the Capital Programs Management Group (Asbestos Management Program for asbestos abatement).

1.7 Warranty and Maintenance

1.7.1 Spare Parts - Fire

The Contractor shall supply as spares, 10% of ALL Devices and a minimum of five (5) sets of (2) “Cat 30” keys shall be provided, appropriately identified, and turned over to Capital Programs Management Group.
1.7.2 Warranty

The contractor shall warranty all materials, installation and workmanship for two (2) years from date of acceptance, unless otherwise specified. A copy of the manufacturer's warranty shall be provided with close-out documentation and included with the operation and installation manuals.

The System Supplier shall maintain a service organization with adequate spare parts stock within 75 miles of the installation. Any defects that render the system inoperative shall be repaired within 24 hours of the owner notifying the contractor.

1.8 Training

The System Supplier shall schedule and present a minimum of 4 hours of documented formalized instruction for the building owner, detailing the proper operation of the installed System.

The instruction shall be presented in an organized and professional manner by a person factory trained in the operation and maintenance of the equipment and who is also thoroughly familiar with the installation.

The instruction shall cover the schedule of maintenance required by NFPA 72 and any additional maintenance recommended by the system manufacturer.

Instruction shall be made available to the Local Municipal Fire Department if requested by the Local Authority Having Jurisdiction.

FIRE ALARM SYSTEMS PART 2 - Products

2.1 Manufacturer - Fire

The manufacturer of the system equipment shall be regularly involved in the design, manufacture, and distribution of all products specified in this document. These processes shall be monitored under a quality assurance program that meets the ISO 9000 requirements.

All System components shall be the cataloged products of a single supplier. All products shall be listed by the manufacturer for their intended purpose. Edwards Systems Technology, Inc. products (as supplied by a licensed distributor to assure Campus Network compatibility) constitute the type of equipment to be installed.

All control panel assemblies and connected field appliances shall be both designed and manufactured by the same company, and shall be tested and cross-listed as to ensure that a fully functioning system is designed and installed.

The system supplied under this specification shall be a microprocessor-based direct wired, multi-priority peer-to-peer networked system. The system shall utilize independently addressed, microprocessor-based smoke detectors, heat detectors, and modules as
described in this specification.

2.2 Panel Components & Functions

2.2.1 General – Fire

The control panel shall be a multi-processor based networked system designed specifically for fire applications. The control panel shall be listed and approved for the application standard as listed under the General section. The Panel shall be an Edwards [EST3] Network system installed in a CAB-21 enclosure, and all panels, and boosters including FACP shall be keyed CAT-30.

The control panel shall include all required hardware, software and site specific system programming to provide a complete and operational system. The control panel shall be designed such that interactions between any application can be configured, and modified using software provided by a single supplier. The control panel operational priority shall assure that life safety takes precedence among the activities coordinated by the control panel.

The control panel shall include the following capacities:
- Support up to 2500 analog/addressable points.
- Support network connections up to 63 other control panels and annunciators.
- **Support multiple communication ports and protocols**
- Support up to 1740 chronological events.

The network of control panels [nodes] shall include the following features:
- The ability to download all network applications and firmware revisions from the [FireWorks] computer at a single location on the system.
- Provide electronic addressing of analog/addressable devices.
- Provide an operator interface control/display that shall annunciate command and control system functions.
- Provide a discreet system control switch provided for reset, alarm silence, panel silence, previous message switch, next message switch and details switch.
- Provide system reports that provide detailed description of the status of system parameters for corrective action or for preventative maintenance programs. Reports shall be displayed by the operator interface or capable of being printed on a printer.
- Provide an authorized operator with the ability to operate or modify system functions like system time, date, passwords, holiday dates, restart the system and clear control panel event history file.
- Provide an authorized operator to perform test functions within the installed system.
- Provide an authorized operator to perform [password protected] control bypass functions within the installed system.
- Fire alarm network workstation shall be able to access any local FACP functions.

The control panel shall contain a standby power supply that automatically supplies electrical energy to the system upon primary power supply failure. The system shall include a charging circuit to automatically maintain and supervise the electrical
charge of the battery.

2.2.2 Operator's Interface - Annunciation

The system shall be designed and equipped to receive, monitor, and annunciate signals from devices and circuits installed throughout the building. Standard LED annunciators may be combined in common enclosures provided that the groups of LED's comprising each of the required annunciators are separated from one another (i.e. Alarm Detection, Supervisory, and Trouble Status) and clearly labeled. Note: Any [remote] annunciators shall be programmed to annunciate alarm conditions only.

Receipt of alarm, trouble, and supervisory signals shall activate integral audible devices at the control panel, and [alarm signals only] at each remote annunciation device. The integral audible devices shall produce a sound output upon activation of not less than 85 db at 10 feet.

The annunciator shall contain the following system status indicators:

- 168 character Backlit Liquid Crystal Display
- System Normal Indicator
- System Common Alarm Indicator
- System Common Trouble Indicator
- System Common Supervisory Indicator
- System Ground Fault Indicator
- System Common Security Indicator
- System Disabled Point Indicator
- System Reset Switch with Indicator
- System Alarm Silence Switch with Indicator
- System Trouble Silence Switch with Indicator
- System Message Queue Scroll Switches.
- 10-Digit Keypad to Enable/Disable System and Functions.

The LED Annunciator rows shall contain the following format:

Provide one row of red (alarm) and yellow (trouble) LED's. LED's in each row shall be arranged in columns, one column per type of alarm initiating device, and shall illuminate upon receipt of an alarm signal from the associated device (i.e., electrical room smoke/heat detector).

Provide one row of red (alarm) LED's. LED's in each row shall be arranged in columns, one column per type of alarm initiating device, and shall illuminate upon receipt of an alarm signal from the associated device (i.e., electrical room smoke detector).

2.2.3 Primary Power Supply

- System power supply shall provide multiple power limited 24 VDC output circuits as required by the panel.
- Upon failure of normal (AC) power, the affected portion of the system shall automatically switch over to secondary power without losing any system functions.
Each system power supply shall be individually supervised. Power supply trouble signals shall identify the specific supply and the nature of the trouble condition.

All standby batteries shall be continuously monitored by the power supply. Low battery and disconnection of battery power supply conditions shall immediately annunciated as battery trouble and identify the specific power supply affected.

All system power supplies shall be capable of recharging their associated batteries, from a fully discharged condition to a capacity sufficient to allow the system to perform consistent with the requirements of this section, in 48 hours maximum.

All AC power connections shall be to the building's designated emergency electrical power circuit and shall meet the requirements of NFPA 72 - The AC power circuit shall be installed in a conduit raceway.

The dedicated power circuit disconnect means shall be clearly labeled FIRE ALARM CIRCUIT CONTROL and shall have a red marking. The location of the circuit disconnect shall be labeled permanently inside the each control panel or booster the disconnect serves.

2.2.4 Reports

- The system shall provide the operator with system reports that give detailed description of the status of system parameters for corrective action, or for preventative maintenance programs. The system shall provide these reports via the main LCD display, and shall be capable of being printed on any system printer.
- The system shall provide a report that gives a sensitivity listing of all detectors that have less than 75% environmental compensation remaining. The system shall provide a report that provides a sensitivity (% Obscuration per foot) listing of any particular detector.
- The system shall provide a report that gives a listing of the sensitivity of all of the detectors on any given panel in the system, or any given analog/addressable device loop within any given panel.
- The system shall provide a report that gives a chronological listing of up to the last 1740 system events.
- The system shall provide a listing of all of the firmware revision listings for all of the installed network components in the system.

2.3 Field Mounted System Components - Fire Initiating Devices

2.3.1 Smoke Detectors & Accessories

2.3.1.1 Analog Addressable Smoke – General

Each analog addressable smoke detector’s sensitivity shall be capable of being programmed individually as: most sensitive, more sensitive, normal, and less sensitive or least sensitive. In addition to the five sensitivity levels the detector shall provide a pre-alarm sensitivity setting, which shall be settable in 5% increments of the detector’s alarm sensitivity value. An alternate alarm sensitivity level shall be provided for each detector, which can be set to any of the five (5) sensitivity settings manually or automatically using a time of day event. In addition to the five alternate sensitivity levels the detector shall provide an alternate pre-alarm sensitivity setting, which shall be
setttable in 5% increments of the detector's alternate alarm sensitivity value.

The detector shall be able to differentiate between a long drift above the pre-alarm threshold and fast rise above the threshold. The detector's sensing element reference point shall automatically adjust, compensating for background environmental conditions such as dust, temperature, and pressure. Periodically, the sensing element real-time analog value shall be compared against its reference value. The detector shall provide a maintenance alert signal that 75% to 99% compensation has been used. The detector shall provide a dirty fault signal that 100% or greater compensation has been used.

The system shall allow for changing of detector types for service replacement purposes without the need to reprogram the system. The replacement detector type shall automatically continue to operate with the same programmed sensitivity levels and functions as the detector it replaced. System shall display an off-normal condition until the proper detector type has been installed or change in the application program profile has been made.

2.3.1.2 Duct Detector Housing

Provide smoke detector duct housing assemblies to mount an analog/addressable detector along with a standard, relay or isolator detector mounting base. The housing shall also protect the measuring chamber from damage and insects. The housing shall utilize an air exhaust tube and an air sampling inlet tube that extends into the duct air stream up to ten feet. Drilling templates and gaskets to facilitate locating and mounting the housing shall also be provided. The housing shall be finished in baked red enamel. Remote alarm LED indicators and remote test stations shall be provided.

2.3.1.3 Smoke Detector - Photoelectric

Provide analog/addressable photoelectric smoke detectors at the locations shown on the drawings. The detector shall have the ability to set the sensitivity and alarm verification of each of the individual detectors on the circuit. It shall be possible to automatically change the sensitivity of individual analog/addressable detectors for the day and night periods. Each smoke detector shall be capable of transmitting pre-alarm and alarm signals in addition to the normal, trouble and need cleaning information. It shall be possible to program control panel activity to each level. Each smoke detector may be individually programmed to operate at any one of five (5) sensitivity settings. Each detector microprocessor shall contain an environmental compensation algorithm that identifies and sets ambient environmental thresholds approximately six times an hour. The microprocessor shall monitor the environmental compensation value and alert the system operator when the detector approaches 75% and 100% of the allowable environmental compensation value.

2.3.1.4 Smoke Detector Guards

Where applicable, smoke detector guards shall be installed at the locations
shown on the drawings. The guards shall be Underwriters Laboratories tested and listed by for use with the smoke detectors they protect. Guard design shall not affect the detector operating sensitivity and shall not reduce the listed detector spacing. The guards shall be constructed of 16-gauge steel with a baked white finish to match the detectors. Tamperproof mounting hardware shall be provided.

2.3.2 Detector Bases – Standard

Provide standard detector mounting bases suitable for mounting on North American 1-gang, 3½ or 4 inch octagon box, min. 2 1/8” 4 inch square box, or European BESA or 1-gang box. The base shall, contain no electronics and support all series detector types.

2.3.3 Manual Pull Stations - Double Action Single Stage

Provide analog/addressable double action, single stage fire alarm stations at the locations shown on the drawings. The fire alarm station shall be of polycarbonate construction and incorporate an internal toggle switch. A locked test feature keyed Cat 30 shall be provided. The station shall be finished in red with silver "PULL IN CASE OF FIRE" lettering. The manual station shall be suitable for mounting on North American 2 ½ (64mm) deep 1-gang boxes and 1 ½ (38mm) deep 4 square boxes with 1-gang covers, and shall be mounted at the required ADA height.

2.3.4 Initiation & Control Modules

2.3.4.1 Relay Module

Provide addressable control relay circuit modules at the locations shown on the drawings. The module shall provide one (1) form “C” dry relay contacts rated at 24Vdc @ 2 amps (pilot duty) to control external appliances or equipment. The position of the relay contact shall be confirmed by the system firmware. Any module shall be 3 feet from the device.

2.3.4.2 Notification Appliance Circuits

Provide addressable notification appliance circuit modules at the locations shown on the drawings. The module shall provide one (1) supervised Class “A” notification circuit. The module shall provide polarized audible / visual selection for 24Vdc @ 2amps, audio outputs at 25Vrms @ 50 watts or 70Vrms @ 35 watts. Each booster P.S. shall have individual module supervised class “A.”

2.3.4.3 Isolation Module

Provide addressable fault isolator circuit with a minimum of 2 (two) per floor. The module shall be capable of isolating and removing a fault from a Class “A” data circuit while allowing the remaining data loop to continue operating.
FIRE ALARM SYSTEMS PART 3 - Execution

3.0 Installation

3.1 Sequence

Installation of the systems shall be conducted in stages and phased such that circuits and equipment are installed in the following order:

1. Coordinate the location and size of all new access hatches with the Capital Programs Management Group.
2. All fire system conduits and AC power conduits must be red.
3. Wiring terminations are device-to-device only, splices and/or wirenut terminations will not be accepted.
4. Pre-test the audible and visual notification appliance circuits.
5. Install all new detection devices.
6. Terminations between field devices and the associated control equipment.
7. Complete contractor pre-test of system before ASU tests the system.
8. Complete system testing with AHJ and ASU representative.

3.2 Special Installation Instructions

All installation procedures and methods are subject to inspection and approval from Capital Programs Management Group.

The installing contractor shall become familiar with ASU standards and policies regarding work in occupied buildings.

Repeated offenses of ASU policies or failure to follow installation procedures and instruction from ASU Project Management will result in dismissal from the project and potential disbarment of the contractor from future work at ASU.

On-site storage of material will be coordinated with Capital Programs Management Group.

Access to locked rooms needs to be scheduled with Capital Programs Management Group a minimum of 24 hours in advance.

The awarded contractor is to field mark all areas where proposed conduit routing will affect asbestos. No cutting, coring, or drilling until the Capital Programs Management Group, Asbestos Management Program has the marked sights verified and abated (if necessary).

Consult with the Capital Programs Management Group regarding any questionable installation procedures or methods than may arise prior to proceeding. Any work not performed per the NEC, ASU standards, and with professional workmanship will be removed and redone at no additional cost to ASU. Conduit shall be ¾” min. If surface raceways are required in finished areas, use beige colored Wiremold 2100. Coordinate locations with Capital Programs Management Group.
3.3 Network Programming

No later than three weeks prior to project completion, the installing contractor will contact ASU to schedule Network programming. Network Programming will start when the new building Fire Alarm System has been 100% tested and accepted by ASU and the State Fire Marshal. Upon acceptance, the contractor will turn over the program disk to ASU. Contractors are to contact ASU prior to Bid for Network programming pricing. After receipt of the system-programming disk, contractor should contact ASU for network programming. When network programming is complete a retest of the new panel will be done as follows: (1) All sprinkler system flow and tamper switches will be tested, (2) all manual pull stations will be tested, (3) A minimum of 10% of all area smoke detectors will be tested. Contractor and ASU will do this test.

3.4 Field Quality Control

3.4.1 Test & Inspection

- All intelligent analog addressable devices shall be tested for current address, sensitivity, and user defined message.
- All wiring shall be tested for continuity, shorts, and grounds before the system is activated.
- The installing contractor shall provide instruments, tools and labor required to conduct the tests available.
- All testing to the system shall be done in the presence of ASU Electrical Services Fire Testing staff and ASU Environmental Health and Safety Department.
- The system, including all its sequence of operations, shall be demonstrated to the Owner, his representative, and the local fire inspector. In the event the system does not operate properly, the test shall be terminated. Corrections shall be made and the testing procedure shall be repeated until it is acceptable to the Owner, his representatives, and the fire inspector.

At the final test and inspection with the State Fire Marshal, a factory trained representative of the system manufacturer shall demonstrate that the system functions properly in accordance with these specifications:

- Prior to any test by ASU and/or the State Fire Marshal (AHJ), a complete system with no troubles, supervisories, or alarms (Green Panel) must be confirmed.
- Testing will be at the discretion of the State Fire Marshal, or ASU Fire Marshal in conjunction with the ASU Electrical Services Fire Testing crew.
- A stamped/approved plan by the State Fire Marshal must be on site to review for testing and any alterations to approved plans must be handwritten on the plans. The State Fire Marshal’s Office is the immediate and legal fire safety professional.
• Copy of “as-built” drawings provided by the contractor prior to the scheduled time of test to be kept and used by our department at their discretion.

• A complete, accurate and up-to-date points list provided by the fire alarm contractor prior to the time of test showing each device address, type and location to be kept and used by our department at their discretion.

• All trades involved with the fire alarm system (including but not limited to: building contractor, fire alarm contractor, elevator contractor, electrical contractor, mechanical contractor, fire sprinkler contractor, etc.) be present at scheduled time of acceptance test to provide all necessary time and material to test each and every individual device involved in the proper operation of the fire alarm system. Tests are conducted to confirm all required functions/operations of the system are compliant prior to final AHJ acceptance test.

• It is recommended that notice be given five business days prior to scheduling of acceptance test to alleviate potential scheduling conflicts involved in allocating time to prepare and conduct such test.

• A valid workorder number with funds is necessary to cover the time and material involved in conducting the 100% acceptance inspection test.

• The representative shall provide technical supervision and participate in all of the testing for the system. All fire alarm testing shall be in accordance with National Fire Alarm Code, NFPA 72 - 1999, Chapter 7.

• A letter from the Contractor certifying that the system is installed entirely in accordance with the system manufacturer's recommendations and within the limitations of the required listings and approvals, that all system hardware and software has been visually inspected and functionally tested by a manufacturer's certified representative, and that the system is in proper working order. All documentation, software, or any other related items associated with the system shall be turned over to Capital Programs Management Group and ASU Electrical Services.
DIVISION 31 - EARTHWORK

31 00 00 EARTHWORK

Description

This section defines earthwork as rough and finish grading required to shape existing grades to design grades for proper site drainage, lawns, shrub and ground cover beds. This section also includes criteria for building and site stormwater retention, which shall be confined on-site in retention areas, ponds or drywells.

Inclusion of the Soil Report in the specifications is not permitted on ASU projects. The Consultant shall make the Report available at his office for Contractor's inspection if they so desire. It is the responsibility of the structural engineer to interpret the report and include specification for soil preparation in accordance with the structural design. The Consultant should be aware that earthwork may involve not only the preparation of soils for building and structure but for parking lots, slabs on grade(sidewalks), landscaped areas, and stormwater drainage. Appropriate reference to other specification sections should be included.

Construction activity that includes clearing, grading and excavating that result in land disturbance of equal to or greater than one acre or disturbance of less than one acre of land area if it is part of a larger common plan of development will be required to obtain permit coverage under the Arizona Pollutant Discharge Elimination System (AZPDES) Construction General Permit. To obtain coverage, submit a Notice of Intent (NOI) and Stormwater Pollution Prevention Plan (SWPPP) to the Arizona Department of Environmental Quality (ADEQ).

Dust generating activities with a total disturbed soil surface area of 1/10 acre or more within Maricopa County will be required to obtain a valid Dust Control Permit from Maricopa County Air Quality Department and implement a Dust Control Plan before beginning the dust generating activity.

Arizona State University’s CPMG may be contacted for guidance in securing AZPDES and Dust Control coverage.

Design Standard

A. Fill

1. Conceptual grade elevations shall be considered and noted on the schematic site plan and soil fill material shall comply with the following:

   a. soil material shall comply with ASTM D 2487 soil classification groups GW, GP, GM,SM, SW and SP;

   b. sub-base material shall be specified as naturally or artificially graded mixtures of crushed gravel, stone, slag or sand;

   c. base course material shall be specified as naturally or artificially graded mixtures of crushed gravel, or stone, conforming to MAG specification 702, Type B;

   d. backfill and fill materials shall be specified as soil free of clay, rock, or gravel larger than 4 inches, debris, waste, surplus construction or other deleterious
material;

e. top soil shall be specified as natural, friable, loamy soil, which produces heavy
vegetative growth, free from subsoil, weeds, sods, stiff clay and stones larger
than 3/4 inch, with a soil pH not exceeding 8.00 nor less than 6.5, total soluble
salts in saturation not exceeding 2,000 parts per million; and,

f. all compaction requirements shall conform to applicable MAG (Maricopa
Association of Governments) specifications.

B. Grading and Retention

1. Calculation and design of site retention and flows shall conform to the most recent
standards of the municipality or jurisdiction where the campus is located.

2. All surface areas will drain by natural gravity flow.

3. Site grades shall direct site water away from all portions of the building, parking lots
and walks at slopes that disperses the run-off at a rate that will not allow pooling or
ponding.

4. The use of drywells should only be used as a back-up means of site water retention,
and should not be relied upon to satisfy total stormwater requirements. ASU does
not have a grading and retention design program for proper design and percolation
requirements. Installation of any and all drywells require an ASU Building Permit.
ASU will register the drywell with ADEQ.

5. The use of sump type pumps for exterior surface drainage is not allowable.

6. Below listed are general design guides for slope amounts:

<table>
<thead>
<tr>
<th>Z Grade</th>
<th>Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. maximum unsupported cut</td>
<td>100%</td>
</tr>
<tr>
<td>b. maximum unsupported fill</td>
<td>50%</td>
</tr>
<tr>
<td>c. maximum practical landscape</td>
<td>40%</td>
</tr>
<tr>
<td>d. maximum lawn slope</td>
<td>33%</td>
</tr>
<tr>
<td>e. maximum walk ramp</td>
<td>5%</td>
</tr>
<tr>
<td>f. maximum wheelchair accessible ramp</td>
<td>8.3%</td>
</tr>
<tr>
<td>g. maximum drive slope</td>
<td>12%</td>
</tr>
<tr>
<td>h. maximum/minimum large flat areas</td>
<td>2% to 1%</td>
</tr>
<tr>
<td>i. minimum landscape or paved areas</td>
<td>1%</td>
</tr>
</tbody>
</table>

7. All areas to be planted with grass or ground cover shall receive a minimum of 12
inch top soil.

8. All finish grades shall be a minimum of 1/2 inch below adjacent walks, drives, curbs,
mow strips and paving.

9. Any existing site area affected by rough or finish grading activity shall be restored to
its original existing condition. Special care should be exercised in design to evaluate
any affects new site work or building will pose on existing site features, retention,
travel, stormwater drainage, or aesthetics.
10. Surplus material shall become the property of the Contractor and removed from the site, unless ASU has expressed an interest in the use of the material. No dumping of surplus materials is allowed in drywells, storm drain inlets, or retention tanks.

11. Rubble, trash and other demolished materials shall be taken to the appropriate dump sites and disposed of legally.

12. Soil testing of compacted fill and/or inspection of caissons will be accomplished and paid for by the owner.

31 10 00 SITE PREPARATION

Description

This section applies to all new buildings, building expansions, utility expansions, parking structures, surface parking lots, Campus mall amenities, or any other design/construction activity that materially changes or effects the current features found on Campus. Areas incorporated in this section are civil surveys, archaeological studies and utility mapping.

Design Standard

A. All sod and top soil shall be stored and maintained by the GC for future re-use on the project or as directed by ASU. The grading site plan shall identify the area where such material shall be stored;

B. All existing built site features shall be noted as to their disposition during and after construction, i.e., removed, relocated, demolished, stored, etc.;

C. All landscape material (trees, shrubs, etc.) and irrigation supply devices shall be noted as to remain, stored, relocated or demolished.

1. All big, historic and specimen trees shall be reviewed by The Arboretum at ASU before demolition to determine value and/or salvagability.

2. If existing plant material is to remain or be stored for future project use, it should be noted as the GC's responsibility to water and maintain such plant material for the duration of construction;

3. The Aboretum at ASU retains the right to full value replacement cost of damaged or removed plant materials.

D. Any existing site feature (built or plant material) shall clearly be identified as to whom will remove, relocate, demolish or store it (the GC or ASU);

E. The GC shall provide appropriate dust control in all stripping and grubbing activity required, per the ASU outline specification; and

F. In the event that any relocated or stored site feature is identified as the responsibility of ASU, the grading or demolition plan shall stipulate that the GC is to notify Capital Programs Management Group a minimum of 72 hours in advance of any site preparation activity.
G. The Arboretum at ASU reserves the right to relocate, remove, or demolish any heritage tree, memorial tree, or special collection.

31 23 00  EXCAVATION & SHORING

Description

This section includes consideration for any anticipated excavation support systems, including all underpinning, sheeting and tiebacks necessary to protect existing structures, workmen, general public, utilities, pavement, etc. during future project development and the construction process.

Design Standard

A. All excavation and shoring shall be done in conformance with OSHA requirements and any other applicable law, rule or statute governing construction excavation and shoring activities on the State of Arizona property and those requirements as set forth in the ASU Front-End specification;

B. Any excavation or shoring occurring in close proximity to pedestrian or vehicular circulation; depth and widths greater than 4'; or remaining open longer than 30 calendar days, must be clearly identified on the plans and brought to the attention of the DPM and/or CPM by the DP, prior to the start of construction, for appropriate action;

C. Capital Programs Management Group, Blue-Stake and the local municipality (if applicable) shall be notified no later than 72 hours prior to any excavation activity;

D. Any area to be excavated or shored extending 6 inches or greater below adjacent natural grade, must be barricaded or fenced (if appropriate) from pedestrian or vehicular traffic;

E. Excavated material not used for backfill of the project shall be transported off-site at the time it is excavated. Material used for backfilling may be stock-piled within the construction staging area (or other area deemed feasible by ASU);

F. The GC shall be responsible for dust control measures during excavation, stock-piling or transport of material on campus, as required by the ASU Front-End specification;

G. Transport of all excavated material shall be coordinated with the CM, ASU DPS and the local municipality or jurisdiction. Special time-of-day restrictions in the transport of material may be necessary depending on the project, and should be specified and coordinated with the DPM.

H. ASU on occasion has use for good quality excavated material, and the DP should specify as a bidding option in such cases, direct transport of such material to other ASU project sites or areas.

I. All compaction requirements shall conform to applicable MAG specifications.
31 31 00  SOIL TREATMENT

Description

This section includes treatment of soils under buildings for termites and under paved areas for control of vegetation.

Design Standard

A. Chemicals shall be EPA certified and approved.

B. Termite treatment is required on new and alteration project under all footings, along foundation walls and under interior slabs on grade and exterior porch slabs.
   1. Chemical for termite pretreatment shall be Termidor SC or Premise.
   2. Chlorpyrifos based chemicals shall not be used.
   3. Mix solutions in accordance with Manufacturer's directions to highest concentration allowable by label.
   4. ASU will require a 5 year warranty for termite pretreatment on new work. Only those manufacturers that can comply with this warranty shall be specified. In alteration/addition work where 5 year warranty is not available, Contractor shall certify application rate.
   5. Contractors shall notify ASU Grounds 24 hours prior to performing any termite treatment.

C. Treatment for weed control shall be applied to soil below paved areas, both asphaltic concrete and Portland cement concrete flatwork, on open soil area and areas covered by decomposed granite.
   1. Application of chemicals shall not be harmful to the roots of adjacent plants.
   2. Chemical for weed control shall be "Surflan" pre-emergent.
   3. ASU requires a 6-month warranty for weed control on new work. Only those manufacturers that can comply with this warranty shall be specified.
   4. Weed barrier shall be used in areas covered by decomposed granite, and shall be woven polypropylene (Baycor #47919 or equivalent), which allows water to penetrate yet keeps weeds in check.

C. Arizona School Boards Association Reporting Hazards/Warning Systems:
   1. Pest-control applicators shall provide the school contact person, through the General Contractor, with notice at least 72 hours prior to the date and time the application of pesticides is to occur, including in such notice the brand name, concentration, rate of application, pesticide label, material safety data sheet, the area or areas where the pesticide is to be applied, and any use restrictions required by the pesticide label. Prior to the application, the applicator shall provide the school contact person,
through the General Contractor, with a written preapplication notification containing the following information:

a. The brand name, concentration, rate of application, and any use restrictions required by the label of the herbicide or specific pesticide.

b. The area or areas where the pesticide is to be applied.

c. The date and time the application is to occur.

d. The pesticide label and the material safety data sheet.

2. The pest-control applicator shall fill out and make all required postings in accord with statute and with owner policy and regulation. The pest-control applicator shall verify owner requirements in adequate time prior to start of work to ensure that the project schedule is not impacted by the owner requirements.

3. The name and telephone number of the applicator shall be attached to any posting. Posting shall be made, at a minimum, at the following locations:

a. The main entrance to all buildings and rooms where pesticide and rooms where pesticide is to be applied.

b. Playing fields where pesticide is to be applied.

c. All main entrances to the school property and playing fields.

d. Any area that may be occupied in a period of seven or more consecutive days during which classes are not conducted on the school premises.

e. Immediately adjacent to any new construction areas where visible upon approaching the construction site.

4. Signs may be removed no less than 48 hours after the pesticide is to be applied, and shall be maintained in a legible condition.
DIVISION 32 - EXTERIOR IMPROVEMENTS

32 12 16 ASPHALT CONCRETE PAVING

Description

This section defines general design parameters for paving, curbs and traffic markings. The DP is required to obtain all information regarding parking stall layout, flow and stall dimensioning from Parking & Transit Services, ASU Department of Public Safety and ASU Handicapped Student Resources, along with formal written approvals of the design concept from these entities at the completion of the SD, DD, and CD phases.

Design Standard

A. In areas where asphalt concrete paving is being proposed for vehicle parking, patching of existing parking areas and new roadways or drives, the design specification shall comply with the following:

1. The aggregate base course to be 6 inch in depth, 100% crushed rock conforming to MAG Specification 702, Type B, compacted per ASTM D1557-78;

2. Bituminous binder course shall be 2 inch thick, conforming to MAG Specifications Section 710;

3. Bituminous surface course shall be 2 inch thick, conforming to MAG Specifications Section 710.

B. Painted traffic markings to be 4 inch wide.

C. No asphaltic concrete curbing or driveway aprons are allowable.

D. Sealer coat shall be applied one year after paving work is completed.

E. Asphaltic concrete pedestrian walkways shall conform to the same MAG and ASTM specification sections cited above, with a 4 inch aggregate base course, 1 inch bituminous binder course and 1 inch" surface course.

F. Dead end driveways are highly discouraged, but if site restrictions mandate this design approach, there shall be a minimum of 20’ of unobstructed pull in length; width equal to the driveway.

G. Minimum parking stall size is 8'-6" x 18'-0", handicap accessible stalls 11'-0" x 18'-0" with a 5’0” unload zone.
32 13 13 CEMENT CONCRETE PAVING

Description

This section includes all general concrete paving for pedestrian travel ways or entry features, that do not have special prominence dictating special design finishes.

Design Standard

A. 6’ design width in areas of low pedestrian travel, 8’ design width in areas of high pedestrian travel, including collector walks at residence hall buildings. Paving continuing or connecting major mall travelways (i.e., Tyler Mall), or major/significant building entries shall be of a width justified by traffic volume and aesthetic precedent.

B. All curb cuts, ramps and level transition shall conform to the most recent edition of ANSI "Specifications for Making Buildings and Facilities to, and Usable for, the Physically Handicapped," Arizona Revised Statues, Title 34.

C. Sidewalks that are 5 feet in width or wider should have 6 inches of concrete over 4 inches of base course.

D. Magnesium floated, with a "rosebud" texture.

E. Expansion joints 20’ maximum in a single run of paving.

F. Architectural scoring or joints to be at the same interval as the design width of the subject travel way. Designers option for widths greater than 8’, or walks requiring special design consideration.

G. An additional 3’ of width is required for walks that are adjacent to surface parking lots, where the edge facing parking is used as a wheel stop or overhang area.

H. Walk intersection corners shall be rounded and at all grade changes shall have appropriate curb cuts and transitions that allow full handicap accessibility and safety.

I. A minimum 12’ radius turn-around area is required for any dead-end walk.

K. Walks over 8’ in width, adjacent to grade changes of over 4 inch, adjacent to planter beds, walks crossing of vehicular travelways, special entry features or major mall connections or extensions shall also consist of a border/curb design as described in Division 03, Section 03 35 23.

L. Minimum parking stall size is 8’-6” x 18’-0”, handicap accessible stalls 11’-0” x 18’-0” with a 5’-0” unload zone.

32 14 40 STONE PAVERS

Description

Generally, the project budget will preclude the use of large areas of stone pavers, however in
limited areas and as accents, the material can greatly enhance the overall aesthetic character of the design.

Design Standard

A. Pavers: 1/2 inch minimum thickness, thick-set. A material should be chosen that is relatively impervious to moisture absorption and has a high degree of slip coefficient. Polished or honed finishes as a major field finish are not acceptable.

32 84 23 SPRINKLER IRRIGATION SYSTEMS

Description

This section applies to site areas that are not watered by the Campus flood irrigation system. The DP shall provide a conceptual irrigation system layout as part of the schematic landscaping plan for budgetary inclusion and general coordination and approval by the ASU Grounds Department. The DP or their consultant should recognize and design irrigation systems based upon the premise of "xeriscape" landscaping design.

Design Standard

A. The contractor will be responsible for all blue staking before and during the project.

B. A.N.S.I. Standards will be followed by contractors when applicable.

C. Trenching

1. Main lines shall be a minimum of 18 inches deep; auxiliary lines shall be 4 inches deeper than the bottom of the head being used.

2. Lines bordering curbs, sidewalks or other hard surfaces shall be held 12 inches away to allow for maintenance and access to the lines.

3. Sand shall be used in all trenches as bedding material for all PVC piping and also used as a covering for all piping. There shall be a minimum depth of 2 inches over the top of all piping.

4. Pipe, drip tubing and control wire being routed under walks, roads or other hard surfaces shall be installed in schedule 40 sleeves.

D. Pipe and Fittings

1. All pipe for main and auxiliary (lateral) lines shall be schedule 40 (after valves). Ratings must be printed on the pipe.

2. All fittings shall be schedule 40, pressure rated PVC fittings or better.

3. Standard specifications for the piping materials shall include that the pipe shall be free from cracks, sunburn, discoloration, holes, foreign materials, blisters inside, bubbles, wrinkles and dents.
4. If pipe is stored outside, it shall be protected from direct sunlight.

5. NO galvanized or schedule 80 nipples, elbows or other fittings shall be used with any PVC pipe installations.

6. ALL main lines shall be looped whenever possible so as to improve pressure and flow.

7. PVC joints shall be primered and glued according to manufacturer's recommendations and wiped clean to avoid glue erosion.

8. Glued joints shall cure for 24 hours before pressure is applied to the lines.

9. ALL MAIN lines shall be first primed, then glued. All pipe 1 inch or larger shall be primed then glued. Glue used shall be Weld-On 711 and primer shall be P-70.

10. Warning Tape: Each line shall have warning tape provided directly above line, 12 inches below finished grade, except 6 inches below subgrade under pavements and slabs. All main lines shall have tracer wires for efficient locating.

   a. Provide Acid- and alkali-resistant polyethylene film warning tape manufactured for marking and identifying underground utilities, 6 inches wide and 4 mils thick, continuously inscribed with a description of the utility.

   b. Provide detectable warning tape with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 2'-6" deep for non-metallic utility pipes, conduit or other underground services outside of building line.

E. Control Wiring

1. Wire size shall be UF-14 direct burial cable and shall be taped together in trench.

2. Control wires must be buried a minimum of 12 inches below finish grade.

3. Lawn, shrub, flower beds, desert and drip areas shall be valved separately and have separate stations on the time clock.

4. Wiring between the sprinkler time clocks and the electric remote control valves shall be color-coded and the neutrals shall always be white.

5. All connections to remote control valves and all splices shall be made with "PIN TITE" connectors and RAINBIRD PT-S5 sealer or pre-filled Pin Tite or approved equal.

6. All wire runs shall have expansion loops at all corners.

7. Electric lines shall be below pipe.

F. Valves
1. Electric remote control valves shall be Rainbird EFB-CP or Rainbird PES (PES should be of plastic design). All master valves shall be Rainbird EFB-CP and shall be of brass construction. Valves are to be labeled and valve boxes permanently marked.

2. Valves should be located, when possible, in grass or gravel areas and five feet from sidewalks, curbs or other hardscapes. Avoid locating valves in areas where curbs and walks or other hardscapes come together.

3. Where possible, valves shall be manifolled together, and each group of valves shall have a quick coupler or hose bib on the pressure side of the valve.

4. Valves shall not be smaller than 1 inch.

5. All valves shall be bedded on pea gravel and said pea gravel shall have a minimum depth of 6 inches.

6. Isolation valves up to 3 inches shall be ball type and constructed of non-corrosive plastic.

7. All valves shall be installed with unaltered manufacturer's Christy I.D. tags.

8. Valve boxes shall be Christy (or equivalent) with locking bolts, tan color in gravel areas, and green in grass areas. Bow-Smiths shall be encased in a 6-inch, round irrigation ‘box.’

G. Clocks

1. New Maxicom clocks shall be housed in Rainbird Rainsafe enclosures. Clocks shall be manufactured by RAINBIRD and shall be MAXI compatible. The only acceptable clock is an ESP-SAT-TW.

2. Clocks shall be mounted OUTSIDE of buildings, tunnels, parking structures, equipment rooms, etc., for easy accessibility in emergencies.

3. All grounding for electrical/lighting protection, surge protection, etc., shall be completed as per RAINBIRD specifications. All flow sensors, transmitters, and pulse decoders shall be installed using RAINBIRD specifications.

4. The MAXI system has been installed on the ASU campus and the contractor shall make hard wire hook up to the nearest cluster control unit, usually closest to the phone equipment room. ASU sprinkler crew will assist in this hook up.

5. Flow sensors, transmitters and pulse decoders shall be required on all irrigation systems. (Minimum of one each per CCV).

H. Sprinkler Heads

1. All lawn heads shall be installed so that head-to-head coverage is accomplished regardless of wind and manufacturer's field tested specifications.

2. Sprinkler heads for lawn areas less than 30 feet wide shall be RAINBIRD 1804 with
VAN nozzles. Final placement of these heads shall be a minimum 4-6 inches from the edge of hard surfaces. The heads shall be on swing joints. The use of polypipe swing joints is acceptable BUT the same manufacturer shall make the polypipe and PVC fittings.

3. Heads for narrow strips of lawn shall be RAINBIRD 1804 with appropriate nozzles. Heads for shrubs and flowers shall be RAINBIRD 1400/1500 or RICHDEL hand adjustable bubblers.

4. Heads for areas larger than 30 feet wide but having some trees shall be RAINBIRD 5000 or HUNTER PGM.

5. Heads for very large open lawn areas shall be RAINBIRD FALCONS.

6. Prevailing wind direction, location of mounds, and location of trees shall influence placement of all heads.

7. All sprinkler heads shall be on swing joints.

8. All lines shall be flushed before the sprinkler heads are installed.

9. The sprinkler system shall be balanced and all heads plumbed to vertical before acceptance by ASU.

I. Drip Irrigation

1. The use of drip irrigation or 1/2 inch black poly tubing on any ASU project is discouraged, and should only be used where runoff of sprinkler water might be a problem due to extreme elevation/grades.

2. Drip emitter type shall be limited to AGRIFIM SUPER-FLO or BOW-SMITH. Spaghetti lines shall be no longer than 8 feet long, and shall be ¼ inch diameter only. Lines shall be buried until about 2 inches to plant and shall be staked. Bow-Smiths shall be encased in a 6-inch, round irrigation 'box.'

J. Backflow Prevention

1. Reduced pressure backflow preventers shall be installed at all connections to water distribution mains.

2. Reduced pressure backflow preventers shall be manufactured by FEBCO.

3. By code, back-flow preventers must be a minimum of 12 inches above grade.

4. Immediately downstream of the back-flow preventer shall be a water meter or MAXI compatible flow sensor of appropriate size. Flow sensors shall be 2 feet before and two feet after any joints to insure accurate readings.

K. Drawings

1. Prior to construction, preliminary design plans must be submitted to ASU Grounds
for approval. At the completion of each project, accurate, reproducible, as-built drawings will be provided to ASU Grounds Services. AutoCad compatible files (*.dwg, *.dxf) will be provided so the sprinkler system may be entered into the campus infrastructure data.

L. Miscellaneous

1. When designing and installing new sprinkler systems at ASU, the following should be observed: 1) When placing sprinkler heads in lawn areas having sidewalks, driveways, etc., all the hard surfaced areas shall be lined with RAINBIRD 1804 sprinkler with van nozzles; rotary-type sprinklers may be used to fill in the large open areas. 2) If the area being designed is an older part of campus with many mature, invaluable trees, care must be taken to ensure that no damage is done to the bark of trees due to water impact from sprinkler heads. 3) All designs must be submitted to the ASU Grounds Services (or the Landscape Architect Coordinator at the ASU at the Polytechnic campus) for approval before installation proceeds.

32 90 00 LANDSCAPING

Description

The entire ASU Tempe campus is a **nationally recognized arboretum**. Displays, special collections, and specimens are a significant part of the Arboretum and any changes/additions require review and approval from the Arboretum at ASU or the Arboretum Committee. The DP should consult the most recent version of the Campus Master Plan to better understand the contextual fabric of the campus landscapes. All campus plant materials are part of the overall cohesiveness of the Campus Arboretum. A general landscaping statement should embrace the uniqueness of the campus Arboretum’s global collection with an understanding of the importance of working within the Sonoran Desert. The Arboretum at ASU encourages a responsible and balanced approach that promotes the use of diverse, drought tolerant, low maintenance, non-native, and native Arizona planting materials. To maintain the quality and diversity of the Arboretum, the placement of new species is highly encouraged. The design team should carefully consider a “xeriscape” approach where and when appropriate. The DP design team should include a landscape architect intimately familiar with Sonoran Desert planting materials and registered in the State of Arizona.

ASU at the Polytechnic campus is creating and developing a Desert Arboretum on the campus. This Arboretum will promote water conservation through use of drought-tolerant plants and efficient irrigation systems.

Design Standard

GENERAL

A. All planting material for new and renovation projects are limited to the selection of materials outlined below or approved by the Arboretum at ASU, and should be scaled, located and/or placed in a manner that both supports and furthers the project's architectural intent, Campus aesthetics, and the health of the plant. Special consideration should be given to specialized collections and rare plants. All endangered and threatened species are required to be permitted and tagged by the Arizona Department of Agriculture, Native Plant Division.
B. The DP's schematic landscaping plan shall clearly indicate the species, number, size, color and general design intent of all landscaping materials proposed. The use of photographs in the design presentation(s) corresponding to the plan is highly encouraged. A copy of the landscape design plan should be submitted to ASU Grounds for all installations. Plans should show irrigation design and hardscape features.

C. The DP's design should carefully consider and avoid any feature or planting material that may present a physical barrier or hazard, nuisance or maintenance problem when fully matured, or at any time during the course of its life.

D. The approximate life expectancy of planting material in a healthy visual state should be seriously considered in selection, and be presented to the ASU Grounds Services.

E. Irrigation shall be provided to each plant dependent upon each plant's specific water requirements.

F. Accent lighting of planting materials is generally not appropriate on Campus, but if the design dictates use of such, it shall be carefully coordinated and approved by the ASU Grounds Services.

G. A water budget shall be calculated for all landscape planting derived from water requirements for each specific planting.

H. Lawns

1. Lawns shall be established by cut sod or hydroseeding. In either case, the soil shall be thoroughly roto-tilled and leveled to receive grass. Hydrospriging shall only be used when absolutely necessary and in locations that will not be impacted by or subject to foot traffic. For sod, soil shall be ½ inch lower than existing grass, to ensure new sod is level with existing grass.

2. Lawn grass shall not be used in any planting strip less than 36 inch wide, unless it is an extension of a continuous larger area.

3. Lawn shall only be used where fully accessible and maintainable for irrigation, mowing, fertilizing and pest control.

4. Seed shall be hybrid Bermuda grass (Cynodon X); sod shall be Midiron Bermuda grass, strongly rooted, not less than 2 years old and machine cut to a pad thickness of 3/4 inch; wintertime overseeding shall be with Rye grass.

I. Trees and Shrubs

1. At ASU at the Tempe campus, trees in pedestrian walkways and/or adjacent to sidewalks shall be single trunk (i.e., tree should have a single-trunk for at least 5 feet before branching out); no multi-trunk trees are allowed in these areas. Trees in lawn areas shall have tree guards acceptable to ASU Grounds Services. Plants that encourage pests or rodents are highly discouraged. ASU Grounds Services will inspect plants proposed for use on campus and reserves the right to refuse specific
plants that they find are not acceptable. Root bound trees are not acceptable.

2. At Polytechnic campus, consult with the Desert Arboretum to determine tree types.

3. All plants shall be types proven to be hardy for the area and situation.

4. The use of 15 gallon trees shall be discouraged in mature landscape areas.

5. Minimum caliper size for new trees shall be 3 inches.

6. Minimum box tree size shall be 24 inches for non specimens and 36 inch for specimens (or larger in key areas).

7. Trees planted in lawn areas shall be provided with 24 inches of bare, sod-free soil beyond and around the full circle of the tree. The cambium layer shall never be buried. Root crown shall be 1 inch above grade. Temporary berms for initial water are acceptable.

8. Trees selected for planting in a designated display or collection area shall conform to the Arboretum specifications for these areas.

9. Deciduous trees shall be planted no closer than 8’ from any walk or drive; evergreens no closer than 2’ greater than the mature radius of branching. Trees with low, horizontal growth habit, or trees with thorns shall not be planted next to streets, bike paths or lanes, or next to sidewalks.

10. All trees shall be planted in holes dug to specifications recommended by the American Nurseryman’s Association and shall be tilled a depth of 12 inch deep at a diameter of 5 times the root ball size. Trees shall be started according to ISA guidelines.

11. All 24-inch (and above) box trees or palms shall have perforated, capped and vented, schedule 40 air sleeves at each corner of the root ball.

J. Obstructions

1. Isolated post in lawn areas shall have a concrete mow strip minimum 7 inch around the post.

2. Obstructions (curbs, buildings, walks, etc.), adjacent to lawn areas, shall have a mow strip and/or apron, a minimum of 12 inch to eliminate unmowable grass.

K. Parking Lots

1. Trees planted in median strips shall be of a type that permits pruning to give a full 10’ clearance at curb side. Trees in these areas should have an upright or longitudinal growth habit.

2. Medians shall be planted with a hardy ground cover.

3. One tree shall be required in new parking lots for every 40 parking spaces.
L. Recommended Plant Guide

1. See ASU Grounds services for latest recommended plant guide.

2. Encouragement of new plant introductions shall be under the guidance of The Arboretum at ASU

M. Soil Preparation

1. All soil and top soil used as a planting media shall conform with the following:
   a. all soil components shall be tested by a testing laboratory for conformance with the specifications;
   b. if herbicide contamination is suspected, then a radish/rye grass growth test shall be performed;
   c. mulches shall be finely ground decomposed pine bark;
   d. ANY manure is NOT acceptable;
   e. chemical additives shall be of agricultural grade, used as necessary to maintain a pH at 6.5 to 8.0;
   f. planting media shall be mixed in the following proportions:
      ▪ planting beds; 22 c.f. topsoil, 5 c.f. sphagnum peat, 4 lbs. soil sulfur, 3 lbs. fertilizer
      ▪ grass areas; 3/4 c.y. topsoil, 1/4 c.y. sphagnum peat
      ▪ trees, shrubs, ground covers; 22 c.f. sphagnum peat, 4 lbs soil sulfur, 3 lbs. fertilizer mixture per c.y.
   g. commercial bagged fertilizer for trees, shrubs and ground cover shall be Ammonium Phosphate (16-20-0), pelleted form and contain a minimum of 16% nitrogen and 20% phosphoric acid.

1. Weed barrier shall be used in areas covered by decomposed granite and in other areas determined by ASU Ground Services, and shall be woven polypropylene (Baycor #47919 or equivalent), which allows water to penetrate yet keeps weeds in check.

N. Maintenance

1. Maintenance shall begin immediately after each portion of lawn and each plant is planted, and shall continue in accordance with the following requirements:
   a. Lawns that have been planted shall be protected and intensively maintained by watering, mowing, fertilizing, and replanting as necessary through a minimum of
90 calendar days or longer, if necessary, to establish a uniform stand of the specified grasses and until acceptable.

b. New plantings and groundcovers shall be protected and maintained until the end of the lawn maintenance period or until final acceptance. Maintenance shall include water, fertilizing, weeding, cultivating, mulching, tightening and repairing guys, removal of dead materials and resetting plants to proper grades.

2. Specifications shall require the GC to keep and store, at its own expense, sufficient quantities of mix for lawn to repair any settling, or to adjust grades throughout the warranty period.

3. Specifications and notes on the landscape drawings shall require the GC to maintain for a minimum of 90 days after acceptance, and accept all responsibility for all plant material until final acceptance of the Work by ASU (exclusive of replacement under the warranty period).

4. Maintenance schedules shall be submitted to and approved by and kept on file with The Arboretum at ASU for the 90 day period prior to final acceptance.

5. Pruning shall be limited to the removal of dead plant material or growth that would harm the overall structure and form of the plant.

O. Decomposed Granite:

1. Decomposed granite at ASU at the Tempe campus shall be ½-inch screen or washed (Madison Gold, Sedona Red, or other appropriate color approved by ASU Grounds), and at ASU at the Polytechnic campus shall be 3/8-inch minus (Desert Rose).

2. If other decomposed granite is approved for a specific project, then specifications (including description, size, color and suppliers) shall be furnished to ASU Grounds.