Facilities Development and Management (FDM) Project Guidelines

Contents

FORWARD

Advice to Architects and Engineer

Your team has been chosen as the architectural/engineering team most 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 for a "cookie cutter" approach to design; hence, there will be many unknowns to your team in working with ASU.

Prior to the beginning of architectural programming, it will be valuable to;

A. Spend time researching the project goals ASU had in mind when preparing the RFQ.
B. Become familiar with campus infrastructure.
C. Become familiar with the University and User Group structure.

The Office of the University Architect (OUA), Design Manager (DM) and Capital Programs Management (CPMG) Project Manager (PM) assigned the responsibility to lead this project on behalf of ASU are your single best resources for the project. **All questions and communications regarding the project, the User Group or the University must be routed through the ASU Project Manager and Design Manager.** This is the established project protocol, and will be further detailed to you by those individuals. It is their responsibility to answer in a timely and professional manner, or direct you to those who can answer specific questions regarding any topic connected with the project.

2. Time Is Money

A common comment we hear from Design Professionals (DP) is that 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 waste 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:

A. Strictly follow 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. Provide finished exhibits, samples and mock ups, as required, to adequately explain the required decision or approval.

B. 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 that a User will instantly or instinctively understand graphic or technical aspects of design without a thorough and concise explanation. Photographs and three-dimensional realistic renderings are invaluable tools to achieve this understanding.

C. Direction, approvals, clarification, etc., must go through the assigned ASU Project Manager and Design Manager. Those that do not originate or go through the assigned Project Manager and Design Manager, no matter the level or subject, are not acceptable and are non-binding.

3. Contingencies

Many architects are under the impression that project contingencies (for design, construction and inflation) are for the use of design “extras.” This is incorrect. 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 critical project function and quality parameters, or “base” scope, as defined by the architectural program and schematic design.

4. Expectations

The Design Team is required to be within the particular design phase budget. If the project estimate at the completion of a particular phase indicates the design is over budget, the team will not receive the necessary approval to proceed to the next phase. The Design Team will then be required to expend the necessary time and effort to bring the design within the budget, at the 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 at all phases of the design process, to account for cost ramifications of the design intent, and avoid promotion and pursuit of design elements that can neither be justified by the program nor are affordable within the project budget.

It is the university's expectation that by following the guidelines, procedures and advice as presented in the ASU Project Guidelines, the Design Team will produce a facility that not only meets program, budget and schedule, but also achieves a quality of *Design Excellence*.

The Design Team is expected to produce Construction Documents that account for the entire scope of the project. Construction Documents shall be coordinated between all disciplines, and are required to be clear, understandable and easy to navigate. Construction documents delivered to ASU with coordination errors, missing scope, lacking detail or have readability issues will not be accepted. The design team will be required to revise to adequate standards at the Design Team’s expense.

INTRODUCTION

Purpose of the Project Guidelines

The Arizona State University Facilities Development Management (FDM) Project Guidelines apply to ASU construction projects managed by the Capital Programs Management Group (CPMG) and/or the Office of the University Architect (OUA) and/or Consultants. All parties are advised to refer to the sections of the Project Guidelines that relate to their projects and to adhere to its guidelines.

Project Guidelines Overview

The ASU Project Guidelines are intended to serve as a tool to assist in the planning, design and construction of ASU FDM projects. The Project Guidelines consist of three interrelated sections:

Section 1: Process Guidelines
The Process Guidelines identify roles and responsibilities of project team members, governing entities and Stakeholders. The Process Guidelines identify the processes and procedures at ASU and provide a guide to common campus resources.

Section 2: Design Guidelines
The Design Guidelines assist the project team by setting expectations for design considerations. The Design Guidelines define ASU's requirements related to functionality, aesthetics, safety, performance and sustainability.

Section 3: Technical Guidelines
The Technical Guidelines assist the project team by providing information on how ASU constructs, operates and maintains buildings and their systems. It defines performance criteria for products, materials and equipment selections as well as considerations for installation, fabrication and construction.

All questions and communications regarding the Project Guidelines shall be directed to the ASU Project Manager (PM) and Design Manager (DM).

Variances to the Guidelines

The FDM Project Guidelines are the minimum requirements for design and construction at ASU. Contractors and Consultants must adhere to the Project Guidelines in all cases, unless a written variance is obtained from ASU. The Design Professional (DP) must submit the "Project Variance Form" to the Project Manager who must obtain written approval from CPMG Executive Director. If the Executive Director is not available, the University Architect has authority to accept or reject the variance.

Every Design Professional **MUST** provide a list of variances, using the "Project Variance Form." If there are no variances, the form must be submitted with "NO VARIANCES" indicated on the form.

The **Project Variance Form** is located online at: https://www.asu.edu/fm/documents/project_guidelines/FDM-Variance-Request-Form.pdf

Updates

The Project Guidelines will be updated as requirements and procedures of ASU and the Arizona Board of Regents (ABOR) change.

SECTION 1: PROCESS GUIDELINES

ASU Office of the University Architect

The Arizona State University (ASU) Office of the University Architect (OUA) Design Manager (DM) works with ASU administration, the User Group(s), the Capital Programs Management Group (CPMG) Project Manager (PM), Design Professional (DP), and Construction Manager (CM) from project initiation and programming through project closeout. The OUA DM manages the planning, programming and design phases to insure compliance with planning, programming, design, and scope requirements for the project; and for conformance to required codes and ASU master plans and procedures.

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

A. Co-manages the Design Professional and Construction Manager selection process with the Project Manager (PM).

B. Manages architectural programming, planning, preliminary design, schematic design and design development phases of the project, including architecture, landscape architecture, classroom design, interior design and signage.

C. Co-manages development and conformance of the project to the program's design, budget, and schedule, and ASU standards with the PM.

D. Manages all meetings between the ASU User Groups, DP and CM during programming through design development.

E. Recommends approval of all payments to DP and CM during programming and design in conjunction with PM.

F. Develops the design professional contract in conjunction with ASU Purchasing and the PM.

G. Reviews Construction Documents and Construction Submittals from DP's for conformance with Project Guidelines and ASU drawing standards.

ASU Capital Programs Management Group

The Project Manager (PM) from the Capital Programs Management Group (CPMG) guides each project from programming through project closeout and warranty. The PM works with the User Group and Construction Manager (CM) to review the Design Professional's (DP) work for compliance with program requirements, design, schedule, budget, and for conformance to required codes and ASU standards and procedures.

The Project Manager (PM) is the direct contact person for the Design Professional (DP), Construction Manager (CM), and other project consultants once the project has completed programming. After project programming is completed, 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 and through occupancy.

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

A. Co-manages the Design Professional and Construction Manager selection process with Design Manager (DM).

B. Co-manages development and conformance of the project to the program, design, budget, schedule, and ASU standards with the DM.

C. Manages all meetings between ASU User Groups, DP and CM after design development.

D. Recommends approval of all payments to DP and CM during construction.

E. Evaluates DP and CM performance for pre-construction~~,~~ in conjunction with ASU Purchasing and

DM. Schedules and coordinates all utilities/equipment shutdowns with Facilities Management (FM) assistance.

F. In conjunction with ASU Purchasing, manages the negotiation for a Guaranteed Maximum Price (GMP).

G. In conjunction with ASU Purchasing and DM, develops the contract for construction [Design/Bid/Build, Construction Manager at Risk (CMAR), or Job Order Contractor (JOC)].

H. Manages all construction administration in conjunction with DM.

I. Manages the construction contract.

J. Manages project close-out.

K. Evaluates DP and CM performance for construction phase in conjunction with DM.

L. Manages warranty issues.

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. A FM representative shall be invited to attend scheduled project meetings in both 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 (FM) project team representative and a Zero Waste (ZW) Program representative will participate as construction team members and/or project reviewers.

FM project representatives act in an advisory capacity to the project and will convey any necessary project issues or information requiring resolution to the DM/PM in the design phases and construction phase for incorporation by the DP.

The responsibility of FM representatives includes, but is not limited to the following:

A. Obtain information regarding ASU infrastructure, maintenance and operation.

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

C. Keep FM shops and administration informed of all project activity, issues and progress.

D. Route all project document submittals to the applicable FM shops for review and comment.

E. Inform and schedule FM shops to attend meetings or reviews as necessary.

F. Attend all regularly-scheduled project design and construction team meetings.

G. Provide Zero Waste (ZW) Program compliance guidance.

ASU University Sustainability Practices (USP)

University Sustainability Practices (USP) is responsible for assisting the ASU community in reaching its ambitious sustainability goals by envisioning, leading, facilitating, and communicating intra-institutional sustainability projects. USP also tracks and reports sustainability metrics for internal and external reporting and celebrating achievements. USP is ASU’s internal sustainability consultant resource.

ASU Sustainable Design Advisory Committee (SDAC)

The Sustainable Design Advisory Committee (SDAC) will review all projects for compliance with ASU’s sustainable design guidelines and specifications and work with the project team to maximize sustainability opportunities. The SDAC shall provide a representative to selection meetings and convene in the Pre-Design or Basis of Design (BOD) phase in order to provide feedback on ASU's priorities for each project. Where applicable, a Return on Investment (ROI) analysis will be included in the review which will include environmental, economic and social costs and benefits.

ASU User Groups

The ASU User Group (or User) are those colleges, organizations or departments that will be the actual occupant 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 Group(s) Representative/Contact Person will be appointed in order to convey consensus opinions, concerns, comments or information to the design team. Appropriate sign-off of the Design Professional's (DP) drawings and specifications by the User Representative 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 be discussed at the regularly scheduled meetings or will be conveyed by the User Representative to the DP through the DM/PM design team leaders.

ASU Permitting and Inspections

An ASU Building Permit Application is required for all construction work, including donated work. Construction work includes, but is not limited to: new construction; demolition; remodels; fire alarm systems; new mechanical, electrical, plumbing and structural systems; replacement of mechanical, electrical, plumbing and structural systems with modifications; hot work; temporary power connections; manufactured housing installations; and other types of projects such as drywell installations, repairs and closures. Depending on the project scope, additional permits may be required by other state agencies. Design, materials and workmanship shall comply with current accepted codes and the ASU Project Guidelines designated in the contract.

ASU Building Permit Applications shall only be initiated by Capital Programs Management Group (CPMG) or Facilities Management (FM). Any exceptions shall be granted by the Executive Director of CPMG. ASU permitted projects shall be inspected to monitor for compliance with accepted codes and standards, ASU Project Guidelines, contract documents and approved plans. For detailed information about current permitting and inspections guidelines: https://cfo.asu.edu/bldg-permit-requirements

For questions about permit requirements contact Plan Review at 480-727-7100.

Asbestos Services

Asbestos becomes a health risk when asbestos-containing materials are disturbed and fibers become airborne and are inhaled. Older buildings often contain asbestos and newer buildings have a threshold amount for disturbance to which ASU complies and enforces:

A. 160 square feet of building materials.
B. 260 linear feet of thermal-system insulation.
C. 35 cubic feet of debris.

Federal, State and County agencies regulate asbestos-related activities at ASU. Only ASU-approved asbestos contractors and consultants are utilized for asbestos-related work. Compliance with asbestos testing for buildings, remodeling or additions over 160 sq. ft. is necessary. Abatement and clearance for Are-occupancy is required prior to issuing an ASU building permit. All ASU properties require an Asbestos review, regardless of the construction date or square footage being disturbed. For reviews including, but not limited to, remodeling, additions, improvements, flooring, window coverings, and suspect paint (which will also be tested for lead, if applicable), an asbestos review is required. To make an Asbestos review request, use the

Request for Asbestos and Lead Services: https://links.asu.edu/FDMServiceRequest.

Do not use asbestos-containing materials in any ASU buildings. Construction may not begin without a Building Permit Application. If this Asbestos and Lead Services Request results in proceeding with your project (estimate, work order, P-card purchases, etc.), an ASU Building Permit Application is required by Capital Program Management Group Building Construction Support Services for Plan Review. The Building Permit Application is located at http://cfo.asu.edu/fdm-forms. After plan review and any subsequent plan review issues are addressed and asbestos and/or lead clearance received, Building Construction Support Services will issue a Building Permit.

For additional information see CPM 301-05: Asbestos Abatement:
https://public.powerdms.com/ASU/documents/1549228

ASU Energy Innovations (EI)

Energy Innovations (EI) spearheads ASU's efforts in three energy-related areas: 1. Renewable energy and renewable energy-generation assets; 2. On-campus energy efficiency initiatives; and 3. Innovative campus energy management projects. In conjunction with senior management and University Sustainability Practices, EI provides strategic direction and the tactical support necessary to achieve ASU's climate neutrality goals by 2025 (carbon neutrality except transportation) and 2035 (carbon neutrality including transportation). In addition to scoping stand-alone SAE projects and key energy efficiency retrofits funded through the SIRF program, EI acts in an advisory capacity on new building construction and major renovation projects.

Solar/Alternative Energy (SAE)

The project team shall consider SAE strategies in the design of all new construction and major renovation projects and roof replacement projects, and with respect to new building construction, the project team shall ensure that on-site SAE is implemented to the greatest extent practicable. The DM and PM shall engage EI in the project's conceptual phase to assist with SAE strategies, specific to solar energy projects, the DP and CM shall refer to the requirements of the SE Design Guidelines.

Solar Energy (SE) Design Guideline

The SE Design Guidelines are applicable for all new SE projects at ASU. These guidelines have been established to address the most common SE design elements at ASU. They are to be used in conjunction with the requirements set forth by applicable codes, laws and ordinances of this jurisdiction, recognized industry standards, good industry practice and specific program needs. Energy Innovations will assist the project team in the development of SE strategies at ASU.

The ASU Solar Energy Design Guidelines are located online at:
https://www.asu.edu/fm/documents/project_guidelines/Solar-Alternative-Energy-Design.pdf

ASU ISAAC and Transaction Services

ASU ISAAC and Transaction Services is responsible for coordination of all ASU physical security design, installation, operation and maintenance of all electronic access control, video surveillance, duress and intrusion systems, and physical security projects on, or in, all ASU-owned or -occupied facilities. ISAAC and Transaction Services reviews and assists all projects with building security needs in conjunction with ET (Enterprise Technology Office), ASU Police, Environmental Health and Safety (EHS), and Facilities Development and Management. Sign-off by ISAAC and Transaction Services will be required prior to completion of the design.

State Fire Marshall and ASU Environmental Health and Safety

The ASU Fire Marshal Office (ASU FMO) is designated by the Arizona State Fire Marshal's Office as the Authority Having Jurisdiction (AHJ) over all ASU properties for code compliance of adopted fire and building codes and standards. The Design Professional (DP) shall submit all construction documents for review through the Capital Programs Management Group (CPMG) process, and then forward them to the ASU FMO for review. All deferred system submittals (fire alarm, automatic sprinkler, special extinguishing, fire lines, standpipes, etc.) shall be submitted directly to the ASU FMO for review. EHS also reviews plans and projects for chemical, biological, and radiological processes to include – but not limited to - fuel-burning equipment, lab design for equipment and equipment placement, life safety requirements, and environmental regulatory compliance.

State Historic Preservation Office (SHPO)

Proposed additions or rehabilitation of historic properties must be reviewed by the State Historic Preservation Office (SHPO) for compliance with the *Secretary of the Interior's Standards for Rehabilitation* for any work which may affect the character of an historic property. Historic properties are those which are listed on the National Register of Historic Places or may be eligible for listing. They include buildings, structures, sites, districts or objects. Any ground-disturbing activities also require review for the potential for discovery of archaeological artifacts and archaeological investigation. An archaeological assessment (and subsequent Treatment Plan and investigation, as required) shall be reviewed and approved by the State Historic Preservation Office.

The ASU Historic Preservation Coordinator in the Office of the University Architect (OUA) will assist design teams with compliance and submit the appropriate documentation to the State Historic (SHPO) for review. The DM/PM will coordinate meetings and communication with the Historic Preservation Coordinator.

ASU Enterprise Technology (ET)

The ASU Enterprise Technology (ET) is responsible for all voice and data communication and Structured Cabling Systems (SCS) design for ASU. ET reviews and assists all project design efforts for Technology conformance as defined in the ASU Telecommunications Design Standards and Design Details: https://asu.service-now.com/sp?id=kb_article_view&sysparm_article=KB0010867

Sign-off by ET will be required prior to chompletion of design. The DP is responsible for signing the Design Professional Scope Overview and Acknowledgement Letter for all capital projects. As defined in the referenced letter, the DP is responsible for initiating review meetings with ET at each phase of design (Programming, SD, DD, CD) and incorporating comments from drawing redlines and meeting dialogue.

State Elevator Inspector

Elevator permits and approvals for modernization and new installation must be obtained by the Contractor from the 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) 542-3313.

ASU Police Department

The ASU Police Department (PD) will 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 Design Professional in regard to life safety, security and fire considerations.

ASU Parking and Transit Services (PTS)

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

PTS 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. PTS shall review and sign off on the site plan and construction staging plan prior to design completion. The Design Professional (DP) is responsible for submittals and incorporation of any comments received. If required, PTS will advise the DP regarding campus pedestrian and vehicular circulation, use patterns and construction parking.

Measures specifically dealing with construction are listed on the Parking and Transit Services website: https://cfo.asu.edu/vendor-contractor-parking-policy

If you have any questions, please contact the Project Manager affiliated with your project or Public Transit Service (PTS) Associate Director of Operations at 480-965-9297.

Coordination with Municipalities

ASU campuses and buildings are located in cities across the Valley, State, and the Nation. ASU's intention is to maintain a strong collaborative relationship with each of these municipalities, while reserving its own rights and responsibilities. Most buildings used and occupied by ASU sit on Arizona

Board of Regents land, however some do not. There are many different ownership, maintenance, permitting, and space-use relationship structures in place and it is critical design professionals and contractors developing ASU facilities understand the status of those relationship structures as it relates to their specific ASU project. Those questions must first be directed to the ASU Design and Project Manager. Certain project drawings such as those showing grading, drainage, curb cuts, street tie-ins, water and sewer connections, storm water drainage, etc., may likely require submission to the city where the project is located, which will be determined by the ASU Design and Project Manager.

ASU makes every effort to align its goals with those of the partner municipality in which its campuses and buildings are located. Although outside Design Professionals and Contractors should fully understand the project issues, they are not to negotiate with municipalities on ASU's behalf when these goals may not align. Resolving specific project issues of that kind is the role of Capital Programs Management Group (CPMG) in concert with University Real Estate Development (URED) and others at ASU. Outside Design Professionals and Contractors should feel free to identify potential issues and inquire with the ASU Project Manager about how to best coordinate their resolution with the applicable city.

U.S. Dept. of Agriculture and Dept. of Health and Human Services

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.

Common Acronyms and Abbreviations

This section defines common acronyms and abbreviations used at ASU that might appear in the guidelines, at project meetings, etc. The acronyms are subdivided into categories.

Outside Entities

ABOR	Arizona Board of Regents
AIA	American Institute of Architects
AZBTR	Arizona Board of Technical Registration
CoP	City of Phoenix
CoT	City of Tempe
DoJ	Department of Justice
EEOC	Equal Employment Opportunity Commission
JCCR	Joint Committee on Capital Review
JRC	Joint Review Commission (ASU/City of Tempe)
Mesa	City of Mesa

NAU	Northern Arizona University
NCES	National Center for Educational Statistics
NFPA	National Fire Protection Association
OCR	Office for Civil Rights
OSHA	Occupational Safety and Health Administration
SCUP	Society of College and University Planners
SHPO	State Historic Preservation Office
U of A	University of Arizona
USGBC	United States Green Building Council

ASU Entities

ABS	Auxiliary Business Services
ACE	Alliance for Construction Excellence
AHS	ASU Health Services
BandF	Business and Finance
BFIT	Business and Finance Information Technology
CHS	College of Health Solutions
CLAS	College of Liberal Arts and Sciences
CONHI	College of Nursing and Healthcare Innovation
CPMG	Capital Programs Management Group
CSPO	Consortium for Science, Policy, and Outcomes
CTI	College of Technology and Innovation
DACT	Department of Animal Care Technologies
DEWSC	Del E. Webb School of Construction (part of SSEBE)
DPC	Downtown Phoenix Campus
EH and S	Environmental Health and Safety
EI	Energy Innovations
EOSS	Educational Outreach and Student Services
ET	Enterprise Technology
FDM	Facilities Development and Management: OUA, CPMG and FM collectively
FM	Facilities Management
FSE	Fulton Schools of Engineering
GPSA	Graduate and Professional Student Association
HIDA	Herberger Institute for Design and the Arts
IHO	Institute of Human Origins
ISAAC	Integrated Security for ASU Access Control
KED	Knowledge Enterprise Development
MLFTC	Mary Lou Fulton Teachers College
OGC	Office of General Council
OUA	Office of the University Architect
PD	ASU Police
PTS	Parking and Transit Services
SOLS	School of Life Sciences
SDA	Sun Devil Athletics (formerly Intercollegiate Athletics)
SDF	Sun Devil Fitness
SESE	School of Earth and Space Exploration
SFIS	School for the Future of Innovation in Society
SHESC	School of Human Evolution and Social Change
SNHP	School of Nutrition and Healthcare Promotion Design
SSEBE	School of Sustainable Engineering and the Built Environment
TDS	The Design School
URED	University Real Estate Development
USG	Undergraduate Student Government
WPC	William P. Carey School of Business

ASU Campuses and Buildings

BA	Business Administration
BAC	Business Administration C-Wing
CAVC	College Avenue Commons
CP	Central Plant
CHP	Combined Heat and Power Facility
DPC	Downtown Phoenix campus
HSB	Health Services Building
ISTBx	Interdisciplinary Science and Technology Building
NCP	Northern Chiller Plant
NFAC	Nelson Fine Arts Center
Poly	Polytechnic campus
PageRSSx	Research Support Services
SCOB	Schwada Classroom Office Building
SHESC	School of Human Evolution and Social Change (building)
UCent	University Center (at the DPC)
USB	University Services Building
USE	Urban Systems Engineering
VDS	Vista del Sol
West	West campus

Common Project Acronyms

AHJ	Authority Having Jurisdiction
AFF	Above Finished Floor
ASF	Assignable Square Feet
AV	Audio / Visual
BIM	Building Information Modeling
C of O	Certificate of Occupancy
CAD	Computer Aided Design
CIP	ABOR Capital Improvement Plan
CDP	ABOR Capital Development Plan
CDs	Construction Documents Phase
CM	Construction Manager
CMAR	Construction Manager at Risk
DBB	Design/Bid/Build
DD	Design Development Phase
DG	Decomposed Granite
DSI	Digital Signage Initiative
DP	Design Professionals: the team of architects and engineers
FFE	Furniture, Fixtures, and Equipment
GMP	Guaranteed Maximum Price
GSF	Gross Square Feet
HVAC	Heating, Ventilation, and Air Conditioning
IPD	Integrated Project Delivery
ISAAC	Integrated Security for ASU Access Control
JOC	Job Order Contract
LA	Landscape Architect
MEP	Mechanical, Electrical, and Plumbing
OAC	Owner/Architect/Contractor
P3	Public/Private Partnership
PA	ABOR Project Approval
PAD	Project Approval Document
PAR	Project Approval Request

PEFI	Postsecondary Education Facilities Inventory
PI	Principal Investigator
PD	Project Definition
PDP	Project Definition Phase and Project Definition Package
PM	CPMG Project Manager
RFP	Request for Proposal
RFQ	Request for Qualifications
SD	Schematic Design Phase
SOQ	Statement of Qualifications
TMA	Too Many Acronyms
TPC	Total Project Cost

Common Guideline Terms

ACM	Asbestos-Containing Material
ADA	Americans with Disabilities Act
ADAAG	Americans with Disabilities Act Accessibility Guidelines
ANSI	American National Standards Institute
ASTM	American Society for Testing Materials Standards
BAS	Building Automation Systems
CFM	Cubic Feet per Minute
GSF	Gross Square Feet
kW	Kilowatt
IBC	International Building Code
LEED	Leadership in Energy and Environmental Design
mm	Millimeters
NSF	Net Square Feet
OEM	Original Equipment Manufacturer
PSF	Pounds per Square Foot
PSI	Pounds per Square Inch
PVC	Polyvinyl Chloride
SF	Square Feet
UFC	Uniform Fire Code
UL	Underwriter’s Laboratories
UPC	Uniform Plumbing Code

SECTION 2: DESIGN GUIDELINES

Climate Neutral Construction Guidelines

ASU is committed to achieving its Climate Positive goals, which include climate neutrality for its operations.

Purpose

This guideline is an essential part of ASU's effort to build and operate Climate Neutral Buildings and reduce ASU's carbon footprint in furtherance of ASU's climate goals.

Definitions

ASHRAE: American Society of Heating, Refrigeration and Air-Conditioning Engineers.

ASHRAE 90.1: Energy Standard for Buildings Except Low-Rise Residential Buildings.

Institutional Boundary: A property where ASU has substantial authority to establish and/or make improvements to the environmental sustainability impacts of the facility in accordance with the methodology outlined in ASU's adopted Institutional Boundaries for Sustainability Reporting Task Force Report. These are the properties that ASU includes in its annual sustainability reporting.

MTCDE: Metric Tons of Carbon Dioxide Equivalent

Climate Neutral Building: A building that does not operationally contribute to global climate change on a net, annual basis, achieved through a combination of high energy efficiency, on-site renewable energy, and offsets (carbon emissions mitigation projects).

Prescriptive Measures: In addition to Codes, Standards and ASU Project Guidelines prescribed requirements, the specific energy-related design elements contained within these guidelines that are required to be included in all new building construction projects.

Regulated Energy: The energy used by building systems and components with requirements prescribed in ASHRAE 90.1, including energy used for HVAC, lighting, service water heating, motors, transformers, vertical transportation, refrigeration equipment, computer-room cooling equipment and other building systems, components and process with prescribed requirements.

Unregulated Energy: The energy used by building systems and components that is not regulated energy use (such as by desktop computers and other plug loads).

Scope 1 Emissions: Direct emissions from sources owned or controlled by ASU, such as on-site fossil fuel combustion, fleet fuel consumption and on-site fugitive emissions.

Scope 2 Emissions: Indirect emissions from the purchase of electricity, steam or chilled water.

Guideline

All proposed new buildings that meet the criteria for inclusion in ASU's institutional boundaries for annual greenhouse gas inventory purposes shall (1) be designed and constructed to be highly efficient through energy reduction and reuse strategies and (2) include as much on-site renewable energy as practicable. Each new construction project at ASU shall incorporate and appropriately budget for these two criteria.

Highly Efficient Building Design:

At a minimum, all new buildings shall adhere to a set of Minimum Efficient Building Design Standards below, which include two components: Minimum Performance Standards and Minimum Prescriptive Standards. These standards are in addition to any other standards or guidelines set forth elsewhere in ASU's Project Guidelines.

During the design process, systematic life-cycle cost analysis (LCCA) shall be performed that will provide ASU a comparative analysis between energy savings strategy alternatives that will allow ASU to select the alternatives yielding the most economically advantageous outcome while satisfying the Minimum Efficient Building Design Standards. Refer to ASU's Engineering Design Guidelines for specific LCCA requirements. The official, ASU-determined cost of carbon offsets necessary to achieve a Climate Neutral Building shall be included as part of the LCCA, when determining economic outcomes.

Minimum Performance Standards: Each new building shall be designed such that the proposed building's regulated energy use, exclusive of renewable energy, is at or below a minimum predetermined performance target when compared to the ASHRAE 90.1 – 2010 baseline building ("Baseline"') as follows:

A. Dormitory and laboratory buildings: 30% below Baseline.

B. Administrative and classroom buildings: 50% below Baseline.

C. Mixed-use buildings: a percentage below Baseline commensurate with the above targets, applied proportionally based upon percentage of floor space allocated per building type.

Note:

A. These targets shall apply to regulated energy only. However, efforts to reduce unregulated energy use in the building shall also be pursued in the building's overall design.

B. These targets shall apply to energy use reduction (i.e. Btu and kWh) and not energy cost reduction.

Minimum Prescriptive Standards: The following prescriptive measures shall be incorporated into the design, whenever applicable. Notwithstanding the above, a prescriptive measure can be replaced with an alternative approach (affecting the same equipment or process), if such alternative approach results in both the same or less energy use and the same or less total cost of ownership as demonstrated by the LCCA. Additionally, nothing in this guideline shall prohibit the implementation of measures that are more energy efficient than the Minimum Prescriptive Standards.

PRESCRIPTIVE MEASURES		
MEASURE	**DESCRIPTION**	**TECHNICAL REFERENCE**
AIR SYSTEMS		

ASPM-1	Static Pressure Reset Control	The static pressure should be reset based on the zone requiring the most pressure, as monitored by the DDC of the individual VAVs.The setpoint should reset lower until one zone damper is nearly wide open.	ASHRAE 90.1 - 2016 Section 6.5.3.2.3
ASPM-2	Proper Location of Static Pressure Sensor	The location of the static pressure sensor should be located so that the static pressure setpoint is minimized with the given mechanical system. Static pressure should be no greater than 1.2 in of water.	ASHRAE 90.1 - 2016 Section 6.5.3.2.2
ASPM-3	Demand Control Ventilation	For spaces and occupancies listed in the citation, demand control ventilation should be used to vary outdoor air supply to those areas.	ASHRAE 90.1 - 2016 Section 6.4.3.8
ASPM-4	Fan System Power and Efficiency	Allowable fan horsepower shall be calculated using Option 2 of Table 6.5.3.1.1 to minimize total static pressure and right-size the fan motors to decrease total HVAC fan power.	ASHRAE 90.1 - 2016 Section 6.5.3.1
ASPM-5	Return and Relieve Fan Control	Return/relief fans should be served by VFDs and controlled based on outdoor air damper or a differential pressure sensor. The DP sensor should be properly located to maximize control efficiency gains.	ASHRAE 90.1 - 2016 Section 6.5.3.2.4
ASPM-6	Supply Air Temperature Reset Controls	HVAC systems serving multiple zones shall include controls that automatically resets the supply air temperature based on building loads or outdoor air temperature. Exclusions would apply to properly control humidity levels in critical spaces.	ASHRAE 90.1 - 2016 Section 6.5.3.5
HYDRONIC SYSTEMS			

HSPM-1	Location and Control of Differential Pressure Sensors in Hydronic Variable Flow Systems	The DP sensor should be located at or near the most remote end use or the end use requiring the greatest differential pressure. The DP setpoint shall reset lower based on valve positions until one valve is nearly wide open.	ASHRAE 90.1 - 2016 Section 6.5.4.2
HSPM-2	Chilled Water and Hot Water Temperature Reset Controls	Temperature setpoint for hydronic systems should include controls to automatically reset the supply temperature based on representative building load or outdoor air temperature.	ASHRAE 90.1 - 2016 Section 6.5.4.4
HSPM-3	Utilize Campus Central Plant Whenever Possible	Buildings shall connect to district chilled water and steam systems whenever possible, unless another strategy can be proven to be more energy efficient.	NA
HSPM-4	Two-way Control Valves for Variable Flow Systems	Utilize 2-way control valves shall be used. 3-way control valves may be used at remote heat exchangers to maintain minimum flow through the system.	NA
LIGHTING			
LPM-1	Lighting	The Building Area Method shall be used for qualifying building types for which a minimum of 90% of the building floor area functions as one of the building types listed in Table 9.5.1. The Space-by-Space Method shall be used for all other multi-purpose functioning buildings that are not eligible for the Building Area Method.	ASHRAE 90.1 - 2016 Section 9.5 and 9.6
EQUIPMENT			
EPM-1	Energy Star Equipment	Where applicable, Energy Star rated equipment shall be purchased.	NA

EPM-2	Walk-in Coolers and Freezer Measures	When applicable, install demand defrost, evaporator fan staging, auto-close doors, 2-way refrigerant valves, etc.	ASHRAE 90.1 - 2016 Section 6.4.5 and 6.5.11

On-site Renewables:

The resulting overall energy needs (both regulated and unregulated) of the highly efficient building design shall be supplied by on-site renewable energy sources to the greatest extent practicable. In addition to solar photovoltaics, evaluation of other renewable energy sources is encouraged.

Sustainable Design Guidelines

The ASU Sustainable Design Guidelines (SDG's) incorporate and expand upon ASU's Leadership in Energy and Environmental Design (LEED) Silver certification requirements and individual project sustainability goals. Design Professionals (DP's) and Contractors shall incorporate the guidelines into their projects to the greatest extent practicable and also refer to sustainability specifications within the
Technical Guidelines (Section 3 of ASU's Project Guidelines:
https://www.asu.edu/fm/documents/project_guidelines/Project-Guidelines.pdf,
the Solar Energy (SE) Design Guidelines, the Engineering Design Guidelines, Zero Waste (ZW) Program, and the Climate Neutral New Construction Guidelines within the Design Guidelines (Section 2 of ASU's Project Guidelines).

Sustainable Design Priorities and Approach

ASU is a recognized leader in sustainability, higher education and society. All projects are to reflect the responsibility this leadership carries as well as to further this leadership. The ASU Office of the University Architect (OUA) and the Sustainable Design Advisory Committee (SDAC) will work with the project team to maximize sustainability opportunities, assist with analyzing tradeoffs between different sustainable options, and review all projects for compliance with the guidelines.

Integrating sustainability in the earliest stages of the project is imperative. Integrated design from the beginning allows for achievement of the optimal environmental and financial benefits of sustainability. Adding sustainability considerations late in the design and construction process typically involves added cost and re-work, while also compromising the benefits.

For new construction and major renovations*, the sustainable design priorities for a project are to be set on an individual project basis in a kick-off meeting with the project team and the Sustainable Design Advisory Committee (SDAC) early in the project design process. For all other projects, the project's designated design and project manager in coordination with the project team shall determine priorities in the project kick-off meeting.

The International Living Futures Institute's (ILFI) Standards for regenerative buildings and communities should provide aspirational stretch goals, if not explicit certification goals, for project teams. Certification under this initiative will be evaluated on a project-per-project basis vis-à-vis available project budget and long term operational goals. Final recommendations shall be made by the Office of the University Architect and final approval by the Capital Projects Review Committee. Sustainable design and construction for ASU means high performance and regenerative buildings with a strong emphasis on:

A. Passive Solar Design: Passive solar design emphasis means prioritizing orientation, shape, form, surfaceh-to-volume ratios regionally-appropriate exterior envelope design, biomimetic, biophilic and low-maintenance solutions to mitigate climate-related impacts and energy use over that of reliance on mechanical systems. It is about designing for and leveraging climatic conditions and cycles to minimize the need to overcome them through powered and mechanical systems.

B. Dormitory and laboratory buildings: 30% below Baseline.

C. Sense of Place (in terms of climate, habitat and community): Sense of place means leveraging, celebrating and responding to the specific climatic conditions and cycles, natural habitat, history and community culture in which the project is located.

D. Integration with Broader Campus and Community Systems: Few ASU projects are standalone. Almost all reside within a campus or within a broader community or municipal context. Integration means recognizing that the most sustainable solution for a given functional or programmatic need may exist at the project, campus or municipal infrastructure level. The project design should also fit within the context of the existing and planned future facilities around it. Finding the optimal system solution involves evaluating options not just on first-cost, but incorporating Life Cycle Cost Analysis (LCCA) as well as the value of using standardized parts and systems, future infrastructure trends and plans, and resilience. Additionally, the optimal solution may shift over time as technology advances. Nature tends to rely on distributed and nested systems, abundance, and redundancy to provide resilience. Technology is trending similarly and project teams should consider this while integrating with campus and municipal systems and planning for the life cycle of the project.

E. Designing and Building for Resilience: Climate change is already taking place in Arizona and the urban heat island effect is a longstanding trend in the Valley of the Sun that compounds forecasted heat-related climate change impacts. Arizona's climate is forecasted to include rising temperatures, more extreme weather events, less precipitation in the winter (which will increasingly occur in the form of rain rather than snow), and more rain in the summer in concentrated storms. Designing for resilience means incorporating these future climate forecasts into designs in order to future-proof facilities and not solely relying on historical weather data.

Project teams are to design projects to support achievement of **ASU's Sustainability Goals and Vision** (https://cfo.asu.edu/sustainability-goals-and-vision):

A. Circular Resource Systems

B. Climate Positive

C. Collaborative Action

D. Community Success

E. Food Reconnection

F. Optimized Water

G. Personal Action

H. Resilience and Regeneration

The State of Arizona Governor's Executive Order 2005-05 mandates that all new state facilities achieve LEED Silver certification. LEED Silver is the minimum standard for ASU new construction and major renovation projects with Platinum certification as the goal. ASU has pre-determined LEED credits it usually obtains to assist in building design efficiency, as outlined in Section 3: 01 81 13 https://www.asu.edu/fm/documents/project_guidelines/Project-Guidelines.pdf. Compliance with certain LEED credits and sustainability specifications is required for all projects regardless of whether the project is required to achieve LEED Silver certification. All landscape projects are to pursue qualification for Sustainable Sites certification and seek certification when OUA determines it to be appropriate. All parking garages are to pursue qualification for ParkSmart certification and seek certification when OUA and Parking and Transit Services determine it to be appropriate.

Additional Specific Sustainable Design Guidelines

A. Programming and Design

A. Innovation, Creativity and Aesthetics: Innovation and creativity in achieving sustainable design goals are encouraged. Sustainability and aesthetics are not opposing forces that lead to compromise. Innovation and creativity are the tools to leverage synergies and unlock stunning and sustainable design solutions.

B. Building Size: Project teams are to minimize the overall building size (square footage) while meeting the building program requirements. The goal is efficient use of space to reduce overall resource consumption, including embodied energy, operational energy, and building materials.

C. Surface-to-Volume and Surface-to-Floor Area ratios: The overall goal is to reduce surface area requirements for conditioned space square footage so as to minimize the intense insolation prevalent in this region.

D. Design for Future Use: Project teams are to plan for a “100-year building” through flexibility of use and future reuse; no “throw away” buildings. Design interior spaces that are flexible and allow for changes in use. Use standard furniture wherever possible. Minimize use of custom millwork, custom building systems (doorframes, doors, interior windows etc.) to maximize reuse in the future. For retrofits, analyze current space requirements for space efficiency, function, and use proximity.

E. Programming and Space Planning: Project teams are to group spaces or activities with similar program requirements and times of use to allow for zoning efficiency of passive and mechanical energy systems. In essence, plan for the integration of non-occupied spaces as additional thermal buffers. The goal is to reduce energy demand and optimize operational efficiency.

F. Transition Spaces: Project teams are to provide sufficient exterior screening, graduated shade transition courtyards, exterior atrium spaces, shade trellises, etc., to allow the building occupant the opportunity for thermal decompression and eye adjustment.

B. Construction and Finish Materials

Project teams are to seek out materials that comply with the LBC Red List and/or have a Declare Label and/or Living Product Challenge certification. Resources include Mindful Materials (http://www.mindfulmaterials.com/) and the AIA's Materials Matter Pledge (https://www.aia.org/design-excellence/climate-action/zero-carbon/materials-pledge).

C. Building Education

Project teams are to create educational opportunities to engage building occupants with information about their impact on the building's resource consumption and actionable measures to minimize resource waste. The goal is to create real-time dashboards to engage building occupants in understanding their impact on the daily energy “footprint” of the facility.

**Major renovation is defined by The Arizona Board of Regents as projects over 5,000,000 dollars.*

Site Improvement Guidelines

Campus development is guided by four planning principles that relate to ASU's eight design aspirations for a New American University. The four planning principles are:

1.Foster change for the academic and greater community,
2.Connect people and encourage belonging,
3.Embody resilience and sustainability,
4.Inspire commitment to growth and place.

In keeping with ASU's spirit of innovation, the physical manifestation of these principles must foster change to help transform the campus and society. As tangible places, ASU's campuses must connect people to conduct research, enable student success, create knowledge and celebrate the unique landscape we inhabit. By embodying sustainability and resiliency, ASU can leverage its place, connect with the adjacent communities, and engage both locally and globally. By inspiring commitment to people and place, ASU can maintain the support it will need to sustain its mission and allow for individual growth and belonging.

A. General Landscape Principles

The development and implementation of outdoor spaces is crucial to the character, coherence, and comfort of the ASU campuses. The spaces between the buildings on campus form the common campus environment and will be the medium that helps to create the identity and sense of place unique to each campus. While the design of outdoor spaces will be specific to each campus, future landscape architectural design on all the ASU campuses should contribute to the creation of a safe, long lasting, sustainable and viable campus environment that will accommodate all students and all modes of student transport and traffic. Two of the campuses are nationally recognized arboretums and it is the intent of the University that they maintain that status. All interventions in the public realm must understand the contextual fabric of the area, specific campus and contribute to an overall University cohesiveness throughout. All University landscape development will promote water conservation through use of native and drought-tolerant plants and efficient irrigation systems. The University is committed to understanding that water is a precious resource and is encouraging limited use of turf grasses except in special circumstances. Specific landscape guidelines unique to each campus are included as follows:

1) Tempe campus – Sonoran oasis, historic, complex, high density, various building massing and scale, multi-modal, highly pedestrian, highly diverse population, strong regional identity and a site of memories.
2) Polytechnic campus – desert arboretum, maker space, highly diverse population, well positioned in the east valley for growth.
3) Downtown Phoenix campus – urban, high density, highly pedestrian, multi-modal and building rehabilitation and adaptive reuse encouraged.
4) West Valley campus – Sonoran oasis, medium density and scale, transitional landscape at edge, moderately pedestrian, poised for growth and influence in the west valley.

B. Overarching Landscape Principles:

1) Demonstrate ASU's firm commitment to sustainability and innovation through design and best management practices.
2) Create a cohesive identity and sense of place throughout the University and each campus by establishing a unified ground plane with a standardized color and material palette.
3) Landscape architectural design must consider ways to sensitively mitigate and respond to the Sonoran Desert climate for human comfort, shade, encourage interaction among occupants, implement stormwater management systems in creative and effective ways, and enhance the seasonal aspects of the regional flora and fauna.

http://www.asu.edu/purchasing/forms/Site-Improvements-Design-Guidelines-5-30-13.pdf.

Communications Guidelines

The Telecommunication Design Guidelines are maintained by the ASU's University Technology Office. The latest revision can be found at the link below:

https://asu.service-now.com/sp?id=kb_article_view&sysparm_article=KB0010867

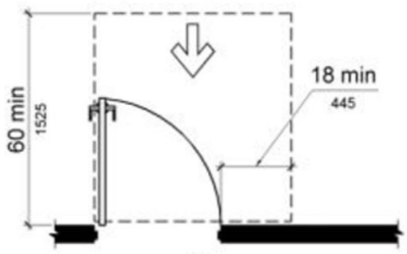
Accessibility Standards

The ASU Accessibility Standards provide additional requirements that supplement the Americans with Disabilities Act Standards. The following Standards shall be considered for all new renovations, remodels, and new construction. Current local, state, and federal accessibility codes apply (ADA/ ANSI/ IBC).

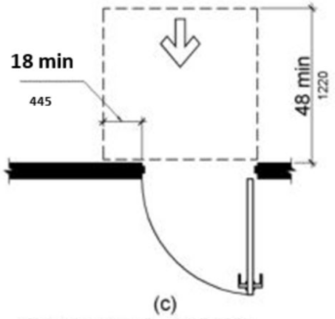
A. **Accessible Routes (including construction and landscape)** – ASU Requirement
  1. Construction Site
    a. Fencing shall enclose all construction areas. Warning tape is not acceptable as the blind and visually impaired are unable to see the tape.
    b. Ramps to sidewalks or buildings shall not be blocked by vehicles or equipment.
  2. Decomposed granite shall not be used on main pathways. Wheelchairs users find this difficult to travel on and it is expensive to maintain.
  3. Emergency Blue Light
    a. The maximum height to operable parts of the emergency blue light shall be measured from the surface of the accessible clear floor space. Locate Blue light adjacent to sidewalk. An accessible clear floor space of 30"x48" shall be provided.
  4. Where curb ramps are provided, detectable warnings shall be provided as follows
    a. Curb ramps within ASU property shall be built to include ¼" x ¼" grooves 2" apart on center for the full width of the run, and 24" min. (from the back of the curb).
    b. Curb ramps within the jurisdiction rights-of-way shall be built per local building code.
  5. The minimum maneuvering clearances for all Doors and Gates, including Entrances and Utility rooms shall extend the full width of the doorway and the required latch side or hinge side clearance. Doors and Gates shall have maneuvering clearances complying with this Table:

Table: Maneuvering Clearances at Doors and Gates

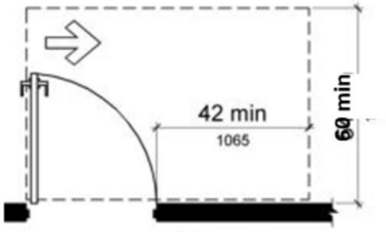
Type of Use		Minimum Maneuvering Clearance	
Approach Direction	Door or Gate Side	Perpendicular to Doorway	Parallel to Doorway (beyond latch side unless noted)
From front (figure a)	Pull	60 inches (1525 mm)	18 inches (445mm)
From front (figure c)	Push	48 inches (1220 mm)	18 inches (445 mm)
From hinge side (figure e)	Pull	60 inches (1525 mm)	42 inches (1065 mm)
From latch side (figure k)	Push	48 inches (1220 mm)	24 inches (610 mm)



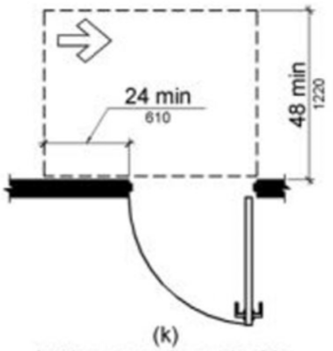
(a)
front approach, pull side



(c)
front approach, push side,



(e)
hinge approach, pull side



(k)
latch approach, push side,

B. **Elevators** – ASU Requirement
   1. Per ASU Project Standards, a minimum of two (2) elevators are required for any building over one story.

C. **Automatic Door Openers** – ASU Requirement
   1. Automatic Door Openers are required on accessible exterior entry doors, primary entrances, suite entrances, restrooms, unisex restrooms, designated accessible dorm rooms, and classrooms/labs with greater than 100 occupants.
      a. A 4 ½" square push pad or 6 ¼" round brushed stainless steel push pad is acceptable.
      b. Door opener actuator shall be 31-33" on center, above finished floor.
      c. Actuators shall be located no less than 24" away from the latch on the push side of the door and no less than 24" away from the latch on the pull side. If actuator is located on the hinge side AND is on the pull side of the door, allow for a min of 24" plus the width of the door.
      d. Openers shall still be activated for exiting purposes, even after regular business hours.

D. **Rest Rooms and Shower Rooms** – ASU Requirement
   1. Accessible Water Closets
      a. Provide automatic flush actuators.
   2. Accessible Toilet Stalls

  - a. Pull handles shall be installed on BOTH sides of accessible stall doors at 36” o.c. height, near the latch.
2. Accessible Urinals
   - a. Provide automatic flush actuators.
3. Accessible Lavatories
   - a. Provide automatic faucet actuators at lavatory in Unisex restroom and at least one (1) accessible sink in each public restroom.
4. Shower Rooms
   - a. Shower stalls are not allowed in Unisex restrooms – ASU liability requirement.
5. Toilet Rooms
   - a. Serpentine entrances at public restrooms preferred if possible. Eliminates all barriers.
6. Unisex Restrooms
   - a. For new construction, unisex restrooms are required on each floor.
   - b. Automatic locking devices with Mag-locks are required in all Unisex restrooms.
   - c. A duress switch must be provided on the device in case of an emergency
   - d. Timers of Automatic locking devices set to 30 minutes.
   - e. Include at least one accessible floor urinal in each public building.

E. **Provide Universal Changing Places** - ASU Requirement per AZ State Law

1. Install a Universal adult-size changing table:
   - a. Include at least one in each new or totally renovated restroom in a public building that:
     - i. Is accessible to both men and women (or installed in both men’s and women’s restrooms)
     - ii. Is capable of serving both babies and adults
       1. Suggested table width: 24” minimum
       2. Suggested table length: 55” minimum
     - iii. Provides sufficient clear floor space parallel to the long side of the table not less than 30” wide and 60” long to comply with the 2010 Americans with Disabilities Act (ADA) standards for accessible design
   - b. That shall be designed to hold at least 350 lbs.
2. If provided as a fold-down table:
   - a. It shall be installed so that it does not encroach into any accessible clear floor space
   - b. That shall have no operating mechanisms higher than 48”
3. Provide signage that indicates the changing station's location near the entrance to the changing station; and
4. Indicate the changing station's location in the building directory if such a directory exists.
5. Responsible authority may exempt if;
   - a. The installation would not be feasible;
   - b. or installation would result in failure of the ADA;
   - c. or installation would threaten historic property; or the building is not frequented by the public

Commentary: Universal Changing Places are an indispensable aid to weakened or disabled adults and their caregivers. For adults who manage mobility limitations or incontinence, they provide a safe, sanitary, and comfortable space for assisted changing. For caregivers, they provide a secure and convenient platform that reduces the risk of back strain and other injuries.

F. **Provide accessible adjustable height, exam/ stretching tables in new and renovated health facilities and recreation/ fitness facilities** - ASU Requirement

1. Equipment shall be used supine, prone, or side-lying position
2. Transfer surfaces shall be adjustable in height measured from the floor to the top of the uncompressed transfer surface and shall provide the following:
   - a. A low transfer position at a height of 17 inches minimum and 19 inches maximum;
   - b. A high transfer position at 25 inches
   - c. At least four (4) additional transfer positions located between the low and high transfer

positions and separated by 1-inch minimum.
3. End transfer surfaces shall be 28 inches wide minimum and 17 inches long minimum.
4. Side transfer surfaces shall be 28 inches wide minimum and 28 inches long minimum.
5. Each transfer surface shall provide two unobstructed sides for transfer.

Commentary: Availability of accessible equipment is an important part of providing accessible medical care, Doctors and other providers must ensure that medical equipment is not a barrier to individuals with disabilities.

G. **Provide accessible wheelchair scales in new and renovated health facilities and recreation/ fitness facilities** - ASU Requirement.
   1. Portable or permanent scales are acceptable.
   2. 1,000 lb. capacity, minimum.
   3. Two-way built-in ramps for accessibility from both sides is preferred.
   4. 36” x 48” minimum platform size. Ramp sides shall be 36” minimum width.

Commentary: Availability of accessible equipment is an important part of providing accessible medical care, Doctors and other providers must ensure that medical equipment is not a barrier to individuals with disabilities.

H. **Residential Accessible Dorm Rooms** – ASU Requirement.
   1. Locate rooms on the first floor if possible but dispersed 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.
   2. Window sills shall be no higher than 42” so one in a wheelchair can look out
   3. Provide peep hole on door at accessible height (43”) and standing height (60”)
   4. Provide Automatic 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. This device may be activated with a remote control that the student attaches to her/his wheelchair or has in her/his possession. The 'clicker' must be duel frequency
   5. Window covering controls to be extra long so they are accessible (per ADA 308 - Reach Ranges).
   6. Additional power outlet(s) shall be located adjacent to the bed for use of recharging power assist devices.

I. **Residential Accessible Bathrooms within Dorm Room** – ASU Requirement
   1. Private bathrooms to have fully tiled walls and floor.

J. **Shower Stalls in Accessible Dorm rooms** – ASU Requirement
   1. Roll in shower stall to be a minimum of 30” x 60” clear.
   2. Shower curtains are required.
   3. Shower doors are prohibited.

K. **Stair/Steps** – ASU Recommendation
   1. Per ADA 504; Recommendation: Provide visual contrast (light-on-dark or dark-on-light) that is approximately 2 inches wide and located either on nosings or at the leading edges of treads.

L. **Autism-friendly design in new facilities and renovations** – ASU Recommendation
   1. Avoid striped wallpaper in primary or high contrasting colors.
   2. Minimize the use of fluorescent, high-heat tungsten, and halogen lightbulbs. Maximize the use of natural lighting.

3. Separate high stimulus areas (e.g. TV room, exercise room) with low-input transition zones to allow for sensory recalibration.

Commentary: Include “escape” spaces: spaces that are activity free, calming, low-arousal (consider integrating with existing or future “wellness rooms”) A room that allows modification of sensory inputs such as lighting. Music helps people with autism relax, process the larger environment, and modify behaviors. Sensory rooms should be painted white or soft colors to produce a calming effect. Texture can be introduced for added sensory engagement. The room should have a defined sense of enclosure, to promote feelings of safety and security. The room should be designed to be acoustically contained: do not allow outside noises in and prevent noise from within from escaping. Snoezelen Rooms (Dutch for “sniff” and “doze”) are an established sensory room model that can be referenced. Example: https://www.snoezelen.info/

Classroom Design Guidelines

The Classroom Design Guidelines are overarching principles to create functional, flexible and aesthetically-pleasing classrooms. The Classroom Design Guidelines also incorporate the Classroom Space Utilization Guidelines, which are a reporting and planning tool. The ASU Classroom Standards are located online at: https://www.asu.edu/fm/documents/project_guidelines/Classroom-Design-Guidelines.pdf.

Interior Design Guidelines and Typical Room Data Sheets

Revised 202

Each project and end user will be unique and there is no real “standard” office, classroom or lab at the University. We have successful solutions that we have used and promote, in addition to a flexibility to embrace new ideas and concepts to meet the current challenges and design needs.

The intent of the interiors of a project is not only to meet the User or client requests and needs but to continue the ASU identity and standards through the interiors of all campus facilities. The Interior Design Guidelines are to be used as part of the contracted Design Professional’s individual process. This information is intended to guide the Design Professional and not limit design expression or selections. The goal of these guidelines is to expedite the project schedule while maintaining University standards. Exceptions to any design standard may be discussed with the University representatives as appropriate. These guidelines will evolve and be further refined as they are applied to various projects as new situations and needs arise.

In general, all interior design will need to take into consideration:

A. Ergonomic and flexible work and learning environments.

B. Design interior spaces that are flexible and allow for changes in use.

C. Use standard furniture wherever possible.

D. Minimize use of custom millwork, custom building systems (door frames, doors, interior windows etc.) to maximize reuse in the future.

E. For retrofits, analyze current space requirements for space efficiency, function, and use proximity.

F. Storage needs, now and in the future.

G. Security - of information, data, and individuals

H. Lighting - natural and supplemental.

I. Air Quality.

J. Pertinent Codes.

K. Accessibility.

L. Sustainability.

M. Aesthetics.

N. And the overall building and space cohesion as a unit, and a part of the University as a whole.

The detail elements addressing these considerations will need to be thoroughly presented and submitted for review. Within the project planning and review phases the contracted Design Professional can expect to review the proposed designs and finish selections with a representative of the Office of the University Architect (OUA). As the scope and detail of each project will differ, the exact number of and thoroughness of such reviews is project specific. As part of the review process, the Design Professional should be aware there is a potential for a requested mock up and/or sample board. Particularly if the furniture or finishes selected are not current University standards already in use. It is expected that the contracted design team provides timely responses and changes to all review comments.

Finishes:

The User Group, budget, function and a multitude of other elements can factor into general finishes. This creates the importance of the above mentioned finish review meeting(s). Guidelines to take into consideration when selecting finishes for submittal are included in the Design Guidelines Part III in the appropriate Division. The intent is to find a durable, maintainable, sustainable, and aesthetic palette of finishes appropriate for the individual project as it fits into the ASU identity.

In projects involving private offices, it is preferred to minimize or eliminate all accent paint colors. Accent paint colors are encouraged in public spaces and should consider appropriate CIR and Light Reflectance Value (LRV) values for the specific site and project. Large expanses of solid, intense accent colors are discouraged in all environments. Product and application specific guidelines can be found in Part III.

Fabrics:

A. All fabrics should comply with California Technical Bulletin 117 (CAL117) for Flammability.

B. All vinyl fabrics should be PVC free.

C. When applicable, NSF/ANSI 336-2011 ratings and testings should be submitting for fabrics specified.

D. General preferred characteristics:

1. Patterns preferred to solids.
2. Darker patterns preferred to lighter colors.
3. Protective finishes – i.e. Crypton requested.
4. Heavy duty rating preferred.
5. Minimum 100,000 double rubs (Wyzenbeek) for public/high use areas.
6. Minimum 50,000 double rubs (Wyzenbeek) for other areas.
7. AATCC Test Method 8-2013 Colorfastness to Crocking; Minimum Grade 3 rating.
8. AATCC Test Method 16.1 or .3 Colorfastness to Light Grade 4 minimum at 40 hours.

Furniture Design/Selection:

A. Contracted Design Professionals are not limited to using only the furniture lines and dealerships available through the Purchasing Contracts, but are encouraged to familiarize themselves with these options and, when feasible, to choose from them. The purchasing team can be contacted for detailed information on the various contracts available, dependent on project specifics. It is not necessary to use only one of the available furniture dealerships or lines within each of those. The overall cost and complexity of the specification, potential re-use, and overall installation process should be taken into account when making these decisions.

B. In projects where appropriate, a first step in the design process for contracted Design Professionals may be conducting an inventory and evaluation of existing furniture and equipment and presenting results and their recommendations to maximize reuse and reduce waste and project costs.

C. When designing office and work spaces Design Professionals are encouraged to apply a modular planning approach to preserve flexibility of office and work space over time. Flexibility and configurability is as valuable a consideration for maintainability and durability as finishes.

D. In existing buildings, in most circumstances, furniture finish standards have been established and need to be maintained for continuity throughout a building. In some instances, existing buildings also have approved and partially implemented building standard finishes. A representative of the Office of the University Architect (OUA) will have a record of these should they factor into your scope.

E. General preferred furniture characteristics:

1. Caster or glides specified as appropriate for floor covering.
2. Laminate or solid surface tops preferred.
3. Wood or veneer finishes should be used sparingly and appropriately.
4. Never in classroom settings.
5. Poly or rubber table banding preferred to self-laminate edges.

F. Integrated Polyurethane edge preferred.

G. No specifications of finishes or materials that require specialty maintenance.

H. Low maintenance materials.

I. Prefer metal to metal construction methods.

J. BiFMA level ® Certified Products Preferred.

K. Minimum 10-year warranty on parts; prefer lifetime warranty.

The **ASU Proposed Space Standards** are:

Recommended Work Space Types and Sizes				
Job Title/ Position	**Recommended NSF**	**Private Office**	**Shared Office**	**Open Work Station**
Academic Units				
Dean	180-200	X		
Department Chair	100-120	X		
Tenure Track Faculty	100-120	X		
Research Faculty	100-120	X		
Non-Tenure Track Faculty	48-100		X	X
Lecturer	48-64		X	X
Instructor	48-64		X	X
Graduate Student Worker	30-64			X
Undergraduate Student Worker	25-35			X
Emeritus	48-100		X	X
Advisors	48-100		X	X
Full Time Professional Staff	48-100		X	X
Full Time Support Staff	48-64			X
Part Time Staff	30-64			X
Administrative Units				
Senior VP	180-200	X		
Assistant VP	120-160	X		
Director	100-120	X		
Assistant Director	48-100		X	X
Full Time Professional Staff	48-100		X	X
Full Time Support Staff	48-64			X
Part Time Staff	30-64			X
Student Worker	25-35			X

A. An X in the chart above notes the preferred work space type per job title.

B. A private office may be required for individuals who work with sensitive materials, no matter their job title.

C. If staff work hybrid schedules at staggered times/days, desks may be unassigned or shared. The ratio of 7 desks per 10 users is a standard for determining desk count when desks are shared, although units may need to vary this ratio based on their individualized requirements.

Typical Conference Sizes			
Type	**Occupancy**	**Typical NSF**	**Notes**
Enclave	2 to 4	100 SF	AV as required by Unit
Small	6 to 8	175 SF	AV as required by Unit
Medium	10 to 12	250 SF	AV as required by Unit
Large	14 to 20	400 SF	AV as required by Unit

Recommended Quantity of Conference Rooms	
Suites with Primarily Private Offices	1 per 20 occupants
Suites with Primarily Open/Shared Work Spaces	1 per 10 occupants
Suites with Primarily Academic Faculty	15 SF per occupant

A. The size of conference rooms will depend on the needs of the user group

B. The number of large conference rooms should be minimized, sharing with other units in the building or scheduling classrooms is recommended.

C. Furniture and AV are to align with ASU Standards

ASU standard room data sheets :
Typical room examples that are to be used with ASU standards and guidelines, applicable codes and will adjust based on existing conditions. The standard room data sheets are located at
https://www.asu.edu/fm/documents/project_guidelines/room-data-sheets.pdf

Electrical Reliability

The ASU Electrical Reliability Standard defines categories of emergency, standby and normal electrical needed to serve the various loads at ASU. The ASU Electrical Reliability Guidelines are located online at: https://www.asu.edu/fm/documents/project_guidelines/Electrical-Reliability.pdf

Laboratory Guidelines

Revised 2023

The ASU Laboratory Guidelines are located online at:
https://www.asu.edu/fm/documents/project_guidelines/Laboratory-Guidelines.pdf

The ASU Environmental Health and Safety Guidelines are located online at:
https://cfo.asu.edu/design-professionals

ASU Signage Design Guidelines:
http://www.asu.edu/fm/documents/project_guidelines/ASU-Signage-Guidelines.pdf

Signage Design Guidelines and Standards

Revised 2023

The ASU Signage Design Guidelines and Standards are applicable to all properties owned, leased or controlled by ASU, all University departments, agencies and tenants on campus.
The Signage Design Guidelines outline the design guidelines that regulate the design and installation of interior and exterior signage in all buildings and properties owned or leased by Arizona State University. **The Signage Design Guidelines are located at:**

www.asu.edu/fm/documents/project_guidelines/ASU-Signage-Guidelines.pdf

The **Signage Design Standards** illustrate and further define the types of signage and graphic standards that will be applicable to all ASU projects. The ASU Signage Design Standards must be obtained directly from the Office of the University Architect.

Email Request: oua.egd@asu.edu

Solar Energy (SE) Design Guidelines

The SE Design Guidelines are applicable for all new SE projects at ASU. These guidelines have been established to address the most common SE design elements at ASU. They are to be used in conjunction with the requirements set forth by applicable codes, laws and ordinances of this jurisdiction, recognized industry standards, good industry practice and specific program needs. Energy Innovations will assist the project team in the implementation of SE strategies at ASU.

The ASU Solar Energy Design Guidelines are located online at:
https://www.asu.edu/fm/documents/project_guidelines/Solar-Alternative-Energy-Design.pdf

Engineering Design Guidelines

Revised 2023

The Engineering Design Guidelines have been established to address the most common project elements at ASU. They are to be used in conjunction with the requirements set forth by applicable codes, laws and ordinances of this jurisdiction, recognized industry standards, good engineering practice and specific program needs. Omission of reference in these guidelines does not relieve responsibility for compliance with these requirements.

Consultants are encouraged to use professional judgment and ingenuity. The provisions of these guidelines are not intended to prohibit the use of alternative systems, methods or components. The consultant is ultimately responsible for the final design and its performance. Due diligence shall be performed to ensure the design is equivalent or superior to the prescribed elements of the Guideline. As required, the Consultant shall propose modifications to the guidelines to meet specific project goals, conditions and requirements through ASU’s formal variance process.

The ASU Engineering Design Guidelines are located online at:
https://www.asu.edu/fm/documents/project_guidelines/Engineering-Design-Guidelines.pdf

Zero Waste (ZW) Program

ASU has a goal of institution-wide zero waste by 2020. ASU defines zero waste as a 90% reduction in landfill waste from our current business-as-usual status. The University practices this goal through diversion and aversion. Waste is diverted from the landfill through recycling, composting and reuse or repurposing. Waste is averted through reduced consumption.

The goal of the following solid waste and recycling guidelines is to assist construction, renovation and demolition projects achieve the highest diversion rate possible for solid waste. Recognizing funding and time and market restrictions, it is anticipated that a minimum diversion rate of 60% is achievable for all projects.

Three main activities will be addressed in relation to solid waste:

Waste generated by direct project activities (demolition, renovation, installation and construction activities).

Waste generated by incidental activities of contractors, project management staff and other project participants (daily activities associated with office and employee functioning).

Waste generated by any moving and/or occupancy associated with the project (including occupant move-in and out).

The Zero Waste (ZW) Guidelines provide equipment and expectations specific to ASU facilities including new construction, additions, renovations, and leased properties. Consult with ASU Zero Waste Program staff for guidance and approvals.

Design Guidelines

Utilize building materials, finishes and fixtures that meet the following criteria:

Contain the highest post-consumer recycled content.

Are non-toxic.

Are easily disassembled.

Are easily repairable with universal parts.

Are made with materials which are easily diverted locally at the end of life.

Use the least amount of non-recyclable packaging materials.

Are designed to maximize lifespan.

Do not require toxic chemicals to maintain.

Have extended warranties.

Design spaces for optimal waste flow, including the following:

Interior movement of solid waste from front-of-house (FOH) to back-of-house (BOH)

A centralized collection at BOH.

Optimal collection containers are BOH and FOH (see #3 below).

Outdoor Bins/Receptacles

Public/Front of House.

Outdoor custom-combined landfill/recycle bins in areas with high traffic, seating areas, or centralized locations.

Donation bins at all residence hall and upon request by ASU Facilities Management.

For bin specifications, See Section 3, Technical Guidelines, Division 12 93 23 for bin specifications.

Dock/Back of House.

All new buildings and major renovations shall include centralized collection dumpsters to accommodate appropriate separation and handling of solid waste. Right sizing of each dumpster will depend on the building use and anticipated occupancy (consult with ASU Zero Waste Program for compactor sizing).

At a minimum, a recycling compactor, trash compactor and space for front-load organics collection shall be provided.

Each renovated building will require a dumpster-capacity review and plan for changes to the solid waste profile of the building.

Trash and Recycling Site Requirements. The minimum requirement at each new building site is a collection location for commingled recycling, organics collection, and landfill collection. Consult with Zero Waste staff for guidance on volume requirements and site specific needs assessment. Minimum measurements, based on an unobstructed site are as follows (actual requirements may vary per site):

	Front Load	Roll-Off/Compactor
Approach	45’ from end of pad	100’ from end of pad

Grade	Pad and vehicle approach = same grade (max 5% tilt)	Pad and vehicle approach = same grade (0 tilt)
Overhead	24’	30’
Container Pad	Width: 10’ + 2’ per side obstacle + 3’ btw containers Length: container + 8’ Min 6” concrete	Width: 10’ + 2’ per side obstacle + 4’ btw containers Length: container + 8’ Min 6” reinforced concrete (20 ton stationary load)
Service Truck	L 35’ (un-extended) L ~41’ (extended) W 8’6” H 13’ Overhead Clearance 20’ (extended) Wheelbase 20’ Turning Radius 46’ AASHTO Intercity Bus (BUS-14) Bus-45	L 35’ (unloaded) L ~52’ (extended) L 45’ (loaded) W 11’ (w/mirrors) H 12’ Overhead Clearance 24’ (extended) Wheelbase 27’ Turning Radius 65’ AASHTO Intercity Bus (BUS-14) Bus-45

Indoor Bins/Receptacles

Every landfill bin shall be paired with a recycling bin. Multiple locations for paired recycle/landfill bins shall include (but not limited to) community areas, offices, labs, breakrooms, etc.

Combination landfill/recycling bins shall be paired with organics collection bins in kitchenettes, breakrooms, small-to-medium sized public areas, small-to-medium sized event venues, and dining facilities.

Cardboard/Styrofoam recycling (OCC) hampers shall be placed on each floor or other areas, as necessary. Consult with the Zero Waste Program staff for determination.

Future space shall be allocated for organics collection.

For bin specifications, see Section 3: Technical Guidelines, Division 12 93 23.

Environmental Health and Safety Guidelines

ASU Environmental Health and Safety (EHS) oversees and reviews fuel-burning equipment, lab design for equipment and equipment placement, life safety requirements, and environmental regulatory compliance, including but not limited to regulations that apply to chemical, fuel, and oil containers (including transformers), drains and wastewater treatment systems, backflow prevention systems, chemical and biological waste disposal, battery, light bulb and ballast disposal, and spills or other releases.

The ASU Environmental Health and Safety Guidelines are located online at: https://cfo.asu.edu/design-professionals

Unmanned Aircraft Systems (UAS) or Drones Guidelines

ASU recognizes the value and potential involved in the development and use of Unmanned Aircraft Systems ("UAS"), including drones, as part of ASU's academic and research missions. ASU also recognizes that the use of UAS creates certain challenges with respect to the safety and privacy of the ASU community and the public as a whole.

The Federal Aviation Administration ("FAA") and relevant state law regulate the operation of all UAS. ASU adopts this Policy to ensure compliance with those legal obligations and to reduce the risks to the safety, security, and privacy of all individuals.

Any use of UAS on ASU Property or any use by any ASU employee, faculty, or student must receive advance approval in accordance with this policy and must comply with all FAA Requirements and Other Laws and Regulations. The ASU Unmanned Aircraft Systems or Drones guidelines are located online at: https://public.powerdms.com/ASU/documents/1549599

SECTION 3: TECHNICAL GUIDELINES

INTRODUCTION

These guidelines are intended to augment, not supersede, the applicable codes. Any code variances shall be approved in writing by the Arizona State University (ASU) Authority Having Jurisdiction (AHJ).

No variances to past or current Project Guidelines, or completed or in process projects, are to be assumed. Rough order of magnitude (ROM) pricing and Guaranteed Maximum Price contracts will assume compliance with all required Project Guidelines until

Except as otherwise noted herein, these 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. It is up to the Design Professionals and their Consultants to inform the Owner of important changes they intend to implement.

Nothing in these Guidelines is intended to remove ultimate professional responsibility from the Design Professional. In the event that the DP takes exception to some aspect of the Guidelines, it is the responsibility of the DP to bring this situation to the attention of the Design Manager (DM) and Project Manager (PM) so the difficulty can be alleviated.

DIVISION 1 - GENERAL REQUIREMENTS

01 14 00 - Work Restrictions

Description:
The use of powder-actuated devices shall be pre-approved by Arizona State University prior to use. The use of support anchors must be approved by structural engineer.

01 33 16 - Design Data

Description:

Climate Responsive and Passive Systems Design: Design buildings in a climate responsive manner to reduce energy demand, maximize passive heating and cooling, and minimize mechanical HVAC requirements (through building form, orientation, articulated shading, natural ventilation, shaded and high-performance glazing, and interior thermal mass).

Every exterior window shall be shaded appropriately for the window orientation. Consider cleaning and maintenance of windows and shading devices in the design. Provide a shading analysis for review. Insure that operable interior shading is accessible to the building occupants.

Building Envelope: Design the building envelope to minimize heat loss and gain. Exceed the current ASHRAE (American Society of Heating, Refrigerating and Air-Conditioning Engineers) building envelope performance baseline standard by 30% or more. Avoid thermal bridging by providing thermal breaks in the exterior building envelope.

Design Standard:

The following minimum building envelope standards shall be adhered to:

Roof: R-30 (min.) Exterior walls: R-25 (min.)

Exterior glass: U = .33 (max.)/R-3 (min.) measured at center of glass

Maximum glass reflectance: 15%

SHGC: .30 or less

WWR*: 25% total, with the following maximum guidelines per orientation:

East:	10%
South:	30%
West:	10%
North:	30%

*SHGC: Solar Heat Gain Coefficient
**WWR: Window to Wall Ratio

DIVISION 2 - EXISTING CONDITIONS

02 40 00 - Demolition

Description

This section includes site, building and selective demolition. The Design Professional (DP) shall accurately define the scope of the demolition effort required for the project. A demolition plan shall be created to graphically show the extent of the demolition work. The Design Professional shall provide direction in the documents so that the Contractor's practices during demolition reflect the latest environmental concerns and are not obtrusive to University personnel or students.

Construction and Finish Materials: Present opportunities for installation of reused and repurposed materials, including the building shell, structural materials, finishes, fixtures, etc. Utilize Green Globes3 reference guidelines for baseline standard.

Construction Waste: Minimize or eliminate construction waste. Reduce, reuse and/or recycle waste materials to minimize disposal to a landfill.

Design Standard

A. Provisions shall be made in the documents requiring demolition work to be performed without disruption to adjacent occupied areas. This important requirement shall be coordinated with the Project Manager (PM) and it shall be clearly indicated on the documents which demolition conditions are to be observed.

B. The demolition plan shall identify all materials/equipment, etc., to be reused and/or salvaged by either Arizona State University (ASU) or the Contractor. This shall be carefully coordinated with the PM. Drawing should clearly illustrate, graphically, what is being demolished and what is existing to remain. Grey lines typically showing existing to remain, with Dark Black lines showing demolition scope using stronger line weights per typical Architectural drawing standards. Simply noting items is not adequate.

C. Items which are always salvaged by ASU:

1. LED exit lights.
2. Chalk/white boards.
3. EMCS equipment.
4. Meters (all kinds)
5. Door hardware.
6. Drinking fountains.
7. Window blinds.
8. Backflow preventers.
9. Fire alarm devices.
10. Simplex equipment.
11. Lab fixtures.
12. Lab equipment (hoods).
13. Security equipment (access control panels, readers, contacts, buttons, video cameras, exit devices, electrified capable hardware and cabinets).
14. Specimen, historic, heritage and memorial trees.

15. Other Life Safety Equipment [Automated External Defibrillator (AED) and AED Cabinets, Knox Boxes, Knox FDC's (Fire Department Connection), and Fire Extinguishers and cabinets].

D. 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:

1. Wood/Hollow Metal doors.
2. Electrical panels.
3. Mechanical equipment.
4. Ceiling diffusers.
5. Projection screens.
6. Mirrors.
7. Irrigation equipment.
8. Refrigeration equipment.
9. Plumbing fixtures.
10. Casework.
11. Disconnect switches.
12. Elevator equipment.
13. Soap/Paper dispensers.
14. Clocks.
15. Access doors.
16. Trees with the exception of specimen, historic, heritage and memorial trees.
17. Electrical light fixtures.
18. Electrical equipment.
19. Starters.
20. Windows.
21. Transformers.
22. Thermostats.
23. Shelving.
24. HVAC mixing boxes.

E. Items to be diverted from the landfill shall, at a minimum, include:

1. Comingled recycling in offices and lunch areas.
2. Cardboard – corrugated cardboard.
3. Scrap metal – includes mixed scrap metal and semi-precious metals.
4. Wood – includes scrap, pallets, vegetation (excluding oleander).
5. Gypsum board – scrap gypsum/drywall.
6. Inert – concrete, asphalt, clean soil, rock, decomposed granite.

F. The ASU Project Manager is the source of information about disposition of demolished material and/or salvaged items. Prior to finalizing the Construction Documents, the Design Professional (DP) shall conduct a site meeting with the Capital Programs Management Group (CPMG) Project Manager and Zero Waste Program (ZW) personnel to determine precisely which items are to be salvaged, and possible sources for diversion. The documents should then clearly identify what is to be salvaged, by whom, and where it is to be delivered to, or stored. The documents should also clearly identify what is to be diverted and recycled, by whom, and how and where the material will be handled and hauled. It is the responsibility of the DP to have this information properly represented.

1. Implement a Construction Waste Management Plan.
   a. Outline procedures and training for construction waste diversion.
   b. Specify a target diversion rate working with the ASU Design Manager and Project Manager. Identify anticipated streams for recycling.
   c. Establish a tracking system for all solid waste streams. Prepare for a final diversion rate and detailed stream report as part of the final section. (See *Sample Project Waste Diversion Report*, item H.13 below).
   d. Required on all Projects, not just a LEED requirement.

G. The documents must note that the Contractor is responsible for scheduling and overseeing associated demolition or salvage work that is to be performed by the Owner.

H. SPECIAL DEMOLITION NOTES:

1. ASU “A” Tag Items. Note on Documents: All items encountered which contain an affixed Arizona State University control tag ("A" tag) require special procedures for disposal. Contractor to notify Project Manager (PM) when “A” tag items are encountered.
2. Contractor is to review the scope of the demolition plan with Environmental Health and Safety (EHS) 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.
3. 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:
   a. All fluorescent tubes shall be removed and packaged by the Contractor in cartons supplied by the EHS. 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.
4. 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 ASU EHS. After completion of the demolition effort, ASU EHS will remove the drum for disposal offsite. Apportioned disposal costs are then to be charged to the project.
5. All electrical services discontinued with the demolition effort shall be properly "tagged out."
6. Contractor to coordinate the regulatory requirements of the Maricopa County Department of Environmental Quality and to consult with ASU Environmental Health and Safety (EHS) to determine exact requirements. All permits and fees for demolition are the responsibility of the Contractor.
7. ASU has a comprehensive hazardous materials abatement program that precedes typical construction activities. It is the Contractor’s responsibility to be knowledgeable of abatement requirements and have a knowledgeable individual on site during demolition processes.
8. The Contractor is to conduct due diligence in the event it is believed there are additional hazardous materials present in the work area. Work by ASU in no way relieves Contractor of responsibilities relative to identification and proper remedial action of hazardous materials encountered at any time

during construction processes.

9. Weights for all hauled materials must be reported to the ASU Zero Waste (ZW) Program.
10. Zero Waste (ZW) Construction Guidelines are as follows:
    a. Implement a Construction Waste Management policy.
        i. Outline procedures and training for construction waste diversion.
        ii. Specify a target diversion rate in conjunction with ASU Project Managers.
        iii. Identify the anticipated streams to be recycled.
        iv. Establish a tracking system for all solid waste streams. Prepare for a final diversion rate and detailed stream report as part of a final report (See *Sample Project Solid Waste Diversion Report*, item #14 below).
    b. Designate a construction and demolition recycling area.
        i. Every effort must be made to divert as much solid waste as possible from the landfill. This includes renovations and new construction throughout the University system.
        ii. Minimally, diversion shall include:
            a. Comingled recycling – in offices, lunch areas.
            b. Cardboard (corrugated cardboard).
            c. Scrap Metal – includes mixed scrap metal and semi-precious metals.
            d. 6Wood – includes scrap, pallets, vegetation (including oleander).
            e. Drywall – scrap gypsum.
            f. Inert – concrete, asphalt, clean soil, rock, decomposed granite.
    g. Implement a construction purchasing policy.
        i. Establish goals, thresholds and procedures for purchasing construction materials.

11. Monitor compliance and track effectiveness of policy.
    a. LEED Materials and Resources Credit 2 (MR-C2) report.
    b. For non-LEED certified buildings, end of project solid waste diversion report must include.
        i. Project name.
        ii. Each material stream recycled.
        iii. Total weights for each stream recycled.
        iv. Disposal method, hauler, and/or location hauled.
        v. Landfill weights.
        vi. Diversion rate.

12. Reporting: Provide the following reporting information.
    a. LEED Materials and Resources Credit 2 (MRc2) report.
    b. For non-LEED certified buildings, end of project solid waste diversion report must include:
        i. Project name.
        ii. Each material stream recycled.

   iii. Total weights for each stream recycled.
   iv. Disposal method, hauler, and/or location hauled.
   v. Landfill weights.
   vi. Diversion rates.

13. Sample Project Solid Waste Diversion Report.

Date	Material Description	Method/Hauler/Location	Quantity Diverted (tons)
1/2/14	Concrete	Rio Salado	10.00
1/7/14	Wood	Organics Company	3.03
1/9/14	Cardboard	Transfer Station	1.87
1/10/14	Metal	Company ABC	0.43
TOTAL			15.33

Landfilled

Date	Material Description	Method/Hauler/Location	Quantity Landfilled (tons)
1/11/14	Mixed Waste	Transfer Station	6.49
TOTAL			6.49

Total Waste: 21.82 tons Diversion Rate: 70.3%

02 82 11 - Asbestos Abatement

A. No University employee or contractor shall impact or cause disturbance of any building material or structure without prior consultation or a signed permit by the ASU Asbestos Management Group. It will be determined by the ASU Asbestos Management Group if asbestos and/or lead based paint is a concern on your project. This group has primary responsibility for the inspection and abatement of all known asbestos building materials scheduled to be disturbed during the course of construction and/or remodel/renovation projects. The scope of asbestos on all ASU projects shall be coordinated between the ASU Project Manager and General Contractor, and shall include the Asbestos Management Group without exception. Any disturbance of unknown building materials by an ASU vendor without the written permission or clearance by the Asbestos Manament Group will be held responsible for a direct violation of the User Provider Agreement and ASU's asbestos process as outlined in the guidelines. ASU does not allow 3rd parties to coordinate any asbestos related services.

B. Every ASU permit is reviewed and signed by a representative in the ASU Asbestos Management Group. The ASU Building Permit Aplication can be found at:
  1. ASU Building Permit Link

C. Clearance for non permitted projects shall go through the TMA Asbestos Request and Review link at:
  1. Asbestos Request Link

D. ASU Strictly adhears to the following EPA and OSHA Regulations. These regulations are used to coordinate all asbestos related activities by the ASU Asbestos Management Team:
  1. OSHA Construction Industry Standard for Asbestos 29 CFR 1926.1101
  2. OSHA General Industry Standard 29 CFR 1910.1001
  3. OSHA Respiratory Protection Standard 29 CFR 1910.34
  4. EPA National Emission Standards for Hazardous Air Pollutants (NESHAP) 40 CFR 61, Subpart M
  5. Maricopa County Rule 370, section 301.8 – subpart M.

E. The ASU Asbestos Management Group manages lead based paint and some specific project related lead containing building materials. If lead is in question, the request is reviewed and action is taken on a case by case bases. ASU contracts 3rd party consultants through the ASU Asbestos Management Program Group to provide lead based response actions when necessary. ASU and its 3rd party consultants utilze, when necessary, the following lead regulations:
  1. Lead Renovation, Repair and Painting Program (RRP)
  2. Title IV of the Toxic Substance Control Act (TSCA) 40 CFR Part 745

F. For additional information see CPM 301-05: Asbestos Abatement: https://public.powerdms.com/ASU/documents/1549228

DIVISION 03 – CONCRETE

03 31 00 - Structural Concrete

Description:

The Design Professional (DP) is responsible for proper Design, Specification, Documentation, Testing Standards and Procedures as are required by Licensure. No attempt has been made here to inform the DP of those reasonably expectable aspects of service. Nothing herein relieves the DP of the obligation to prepare complete and competent documents.

Design Standard

A. SPECIAL ASU CONCRETE ITEMS

  1. Mock-ups are required for any structural concrete that is to receive a finish treatment such as a sandblasted, exposed aggregate, or bush-hammered finish. Mock-ups shall not be incorporated into the final work.
  2. Minimum concrete compressive strength shall be 3000 psi.
  3. Fiberglass grip form ties shall not be allowed.
  4. Vapor retarder or moisture barrier shall be required for all below grade work.
  5. Penetrating sealers on exposed interior concrete floors shall be compatible with Waxie "Floorstar" products. Sealer or finish should be applied per the manufacturer's instructions and then cleaned and reapplied prior to final acceptance.

6. Slabs shall be depressed (dished) 1/2” deep around all floor drains for a minimum radius of 3’-0”
7. Sealed concrete: Prior to application of sealer, floors shall be cleaned with a “side-by-side” machine, wet vacuum and rinsed.

03 45 00 - Architectural Precast Concrete

Description

This section applies to areas of a building the Design Professional (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. The DP is responsible for all aspects of the appearance, craftsmanship and performance of pre-cast concrete panels. Designs must contain adequate information as may be necessary for initial Owners’ approval and the Contractor’s fabrication and erection.

B. A review of PC elements by the Owner is required. 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.

C. Special Considerations:

1. Documents are to require a full-size panel be created and submitted for the Owner’s approval prior to any casting of final items. The sample is to show special detailing and sealants so that the appearance is properly represented. When approved by the DP and Owner, this panel will become the standard of quality by which all the remaining panels will be evaluated. Non-conforming panels are to be immediately replaced.
2. The documents are to require that finished panels be accepted by the DP and Owner immediately upon installation on the structure. Any deviation from that initial quality level that is subsequently revealed is to be remedied immediately. In the example of damage caused by contractor’s activities, the panel will be replaced. Recast concrete panels shall be water sealed with products warranted against UV breakdown for a minimum of five (5) years.
3. The documents are to require approval of PC panels after erection in place. Any damaged panels are to be replaced immediately at no cost to the Owner.
4. Any panels subsequently damaged during construction through no fault of the Owner are to be removed and replaced regardless of cost, difficulty or impact on schedule. Liquidated damages will apply to the overall schedule irrespective of this type of replacement.
5. Under no circumstances are PC panels to be repaired in an attempt to conceal blemishes or defects.

DIVISION 04 - MASONRY

04 05 00 - Masonry and Mortar

Description:

It is the responsibility of the Design Professional (DP) to properly utilize, design, specify and administer masonry work in the field so that the desired performance and quality are achieved. The DP is to properly specify and detail masonry veneers, applications, joints and fastening systems to protect against moisture infiltration, efflorescence, cracking caused by improper structural back-up materials and excessive maintenance. The DP shall 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.

Design Standard:

A. Depending on the project, the DP may be required to show expertise in masonry design of buildings. If acceptable background cannot be proven, the DP may be required to retain the services of a Masonry Design Consultant and/or eliminate this material from the project.

B. Specifying Masonry products for quality and performance is a very sensitive issue. The DP is to use all necessary resources to ensure that the materials installed in the field achieve the levels of performance required by the Owner.

C. To assist the DP in understanding areas of Owner concern, the following items have been provided as a guide in the DP design and documentation. It is the sole responsibility of the DP to ensure that the finished documents and the administration of the construction achieve the Owner's expectations.

D. The selection of brick for major buildings on any of the campuses will be carefully reviewed with the Office of the University Architect (OUA). The OUA must approve the final specified product and must approve the field sample that is erected for the purpose of demonstrating color, workmanship, etc. before material is laid on the actual structure. Final acceptance of the brick workmanship and color uniformity must also be approved by the OUA.

E. Veneer back-up: 8-inch wide concrete masonry units, or structural steel studs with a ¾-inch fiberglass mesh reinforced concrete backerboard.

F. Veneer Corner Pieces: All masonry veneer designs and detailing shall utilize pre-formed corner units at all outside corner conditions and visible edge terminations. The side of a standard veneer unit shall not be visible in any condition.

G. Any Veneer system shall be a min of 2" thick, "thin-brick" or similar systems are not permitted.

H. Sealer: Waterproofing sealer; guaranteed performance minimum 5 years from UV breakdown.

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

J. Cap: The tops of all masonry walls shall receive a watertight cap, i.e., sheet metal or precast concrete with mechanical flashing under the bed joint to prohibit moisture infiltration and efflorescence. No Mortar Caps are to be proposed.

K. Planters: Masonry veneer on other constructed items that are to be used as planters is acceptable provided that the veneer is completely independent of the "planter" structure itself. The planter is to perform its function independently of any contribution by the veneer. Planters are to be watertight, self-draining and constructed of permanent materials. Welded stainless steel liners are an acceptable planter material. Other systems of planter waterproofing have proven inadequate in the past. Planters above occupied spaces of any sort are not to be proposed - **THIS DESIGN CONFIGURATION HAS NEVER WORKED FOR MORE THAN A SHORT WHILE.**

L. Weep Holes: polyethylene plastic tubing, 1/4 inch diameter x 4 inch long. Weep holes shall be cut back flush to mortar joint.

M. Masonry Workmanship: Workmanship is dictated by local standards. In lieu of these local guidelines, ASU requires the following:

1. For all new and infill masonry work adjacent to existing walls, it is required that a 3'-0" by 3'-0" mock-up wall be constructed to ensure both the brick and cured mortar colors are satisfactorily matched. A minimum of a 3-week curing time for evaluation of the mortar color is required.
2. On new construction, a similarly appropriately-sized mock up shall 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 DP. Tolerances are based on actual dimensions.
4. General Tolerances
    a. **Plumb and Level**
        i. Maximum variation from plumb in vertical lines and surfaces of columns, walls, and arrises: 1/4 inch (6.4 mm) in 10 ft (3 m).
        ii. 3/8 inch (9.5 mm) in a story height not to exceed 20 ft (6 m)
        iii. 1/2 inch (12.7 mm) in 40 ft (12 m) or more.
    b. **Variation from Level**
        i. Maximum variation from level of grades for exposed lintels, sills, parapets, horizontal grooves, and other conspicuous lines: 1/4 inch (6.4 mm) in any bay or 20 ft (6 m).
        ii. 1/2 inch (12.7 mm) in 40 ft (12 m) or more.
    c. **Plan Location**
        i. Maximum variation from plan location of related portions of columns, walls, and partitions: 1/2 inch (12.7 mm) in any bay or 20 ft (6 m).
        ii. 3/4 inch (19 mm) in 40 ft (12 m) or more
    d. **Mortar Joint Thickness**
        i. Should be constructed level, but permitted to vary by ±1/2 in. (13 mm) maximum from level provided the joint does not slope more than ±1/4 in. (6.4 mm) in 10 ft (3.1 m).
        ii. Mortar head joint thickness (allowable deviation from specified or indicated): - 1/8 inch, +1/4 inch.
    e. Actual cross-sectional dimension of columns and walls (allowable deviation from specified or indicated): - 1/4 inh
    f. Adjacent unit faces in plane (allowable deviation from specified or indicated): +/- 1/8 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.

N. The type of mortar joint should be specified. Tooled joints are preferred. Raked and flush joints are discouraged. Any DP proposing raked joints must address his design solution for water infiltration the elimination of efflorescence. That solution must be approved by the DM and PM.

O. The DP is to review the installation of masonry to ensure that the specified materials are being utilized and that the specified tolerances and levels of quality are being preserved. Any deviations are to be brought to the attention of the PM immediately.

P. Mortar: Portland cement, ASTM C150, Normal-Type II, Low Alkali. Hydrated lime. Mortar for repairs to existing structures, especially Historic Preservation projects, to match existing.

Q. Masonry Sealant Matching – DP to specify MATCHING sealant to the selected mortar color. A price increase during construction will not be accepted for a custom matching color. This is required to be a part of the base price. This includes all fire caulking in visible areas (Back of house exempt).

04 43 13 - Cut Stone

Description:

In the design of projects where the Design Professional (DP) proposes the use of cut stone as a veneer on projects, the DP is to use the same care in design and specification should be exercised by the DP as with brick masonry and waterproofing systems. If the DP cannot prove expertise in this area of design, detailing and specification, he may be required to engage the services of a special consultant in this area and/or eliminate this material from the project.

Design Standard:

A. The following outline is provided to alert the DP to Owner concerns. It is the responsibility of the DP to properly address this material in his documents, specifications and field interpretations.

B. Anchors: Stainless Steel and Conforming to latest edition of the International Building Code (IBC) and the design requirements of the Structural Engineer.

C. Native materials are encouraged (i.e. Arizona Sandstone).

D. All cut stone is to be properly sealed and/or treated as is appropriate for its intended use.

E. Sandstone used as an interior finish where it may be touched is to be thoroughly sealed with a product selected by the DP so that it no longer can absorb oils, grease and other common contaminants including cleaners. It is to be resealed upon completion of its installation in place.

F. Sandstone used as an exterior material is to be weather sealed so that moisture cannot penetrate and degrade the material.

G. A mockup of this material must be provided for review and approval. It is to be adjusted as required until the desired effect is achieved.

DIVISION 05 - METALS

05 50 00 - Metal Fabrications

Description:

This section applies to all metal fabrications that will be used by the Design Professional (DP) that have a visual aesthetic impact, both interior and exterior. The DP should carefully design and detail metal fabrication so that they strictly comply with 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:

A. All items of design and detailing are to be performed with professional standards of care consistent with industry practices and code requirements. Applicable items may include: Rough Hardware, Ladders, Nosings, Trim, Pipe Railings, Stairs, Bollards and Architectural features. The following are particular ASU concerns that are to be addressed in the design:

1. Welds should be smoothly ground to match surface texture of parent metal.
2. Adjoining railing splices shall be fully concealed in runs that appear constant.
3. At elbow bends, the design should facilitate mitered joints.
4. The use of expansion bolts to secure railing assemblies to vertical or horizontal surfaces is not allowable.
5. Exterior exposed metal fabrications shall have a permanent and high performance paint system applied. The DP must understand that priming and painting systems are a vital portion of the work and the University expects no rusting, bleed through or coating failures due to poorly-specified products or lack of proper workmanship.
6. All painting is to be specified using products and manufacturer's recommendations based on an integrated painting system that is specifically appropriate for the material being coated.
7. Fabricated ladders shall be OSHA conforming.
8. All stair nosings shall have a permanently applied, non-slip surface, either integral or imbedded, 2 inches wide minimum width of the tread.
9. 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.
10. All fabrications with right angle corners that are exposed to public shall be radiused a minimum of 1/8 inch.
11. 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 of the exposed height below the finished adjacent surface. Bollard designs are to be specifically reviewed with the Project Manager (PM) prior to the completion of the construction documents.
12. 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.
13. Exterior handrails and other steel items exposed to high traffic and the potential for abuse-related wear and damage is to be made of Stainless Steel. Galvanized material may be considered where specifically approved by the Office of the University Architects (OUA).

DIVISION 06 - WOOD, PLASTICS AND 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. This section does not apply to Laboratory Casework.

Design Standard:

A. Endangered or limited tree species used as veneers or solid stock (mahogany, teak, etc.) are not allowable.

B. 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.

1. Soft species used for face veneers, tops, kick plates, bases or any other high impact or abrasion related use are not allowable.
2. Wood thresholds are not acceptable.
3. Millwork and Casework [Architectural Woodwork Institute (AWI) Quality Standards, Premium Grade UNO]. The following are general criteria that the University has found acceptable. The Design Professional (DP) is to make his own design decisions based on input from the Project Manager (PM) and his own technical design criteria and be responsible for the outcome of the design and fabrication. Nothing herein relieves the DP from this responsibility.
    a. Casework or millwork that will be specified as receiving a painted finish should be limited to lower cost species (birch, poplar, etc.).
    b. 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 Woodwork Institute (AWI) publications are available at: http://www.awinet.org/.
    c. All cabinet and millwork tops, sides, dividers, etc., shall be 3/4 inch minimum stock.
    d. Stained veneer materials shall conform to AWI custom grade, minimum thickness 1/16 inch. Architectural Woodwork Institute (AWI) publications are available at: http://www.awinet.org/.
    e. Unexposed framing shall be nominal 1 x 2 hardwood, AWI custom grade.
    f. Doors and drawer fronts shall be 3/4 inch minimum core stock.
    g. Drawer boxes shall be 1/2 inch minimum plywood such as Baltic Birch with minimum 1/4" plywood bottoms.
    h. Synthetic countertops should be 5/8 inch minimum thickness.
    i. 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 unit masonry walls.
    j. All shelving should be designed as fully adjustable, 3/4 inch minimum thickness.
    k. "Line bore and pin" to be acceptable with a minimum of 1" adjustments.
    l. 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.
    m. All cabinet hinges should be concealed and self-closing.
    n. Drawer slides should allow full extension (1 inch longer than total drawer depth) and be specified as heavy duty (100 lb. minimum).
    o. The use of painted particle board 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.
    p. Particle board is not an acceptable material for shelving with greater than a 2' unsupported span.
    q. 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.

- r. 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.
- s. The use of plastic laminate tops and splashes is not recommended for high-moisture areas such as lavatory tops, coffee bar tops, or work surfaces that are repeatedly subject to spillage, water cleaning, or chemical substances.
- t. All exposed cabinet hardware should be specified with a permanent, durable finish that is easily cleanable.
- u. All countertop design shall meet ADA requirements.
- v. 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.
- w. Floors and walls that will be concealed by casework shall be cleaned prior to installation of the casework.

4. All cabinet installations are to be fully sealed to the adjacent surfaces and constructed in such a manner that there is no location where insects or other types of contaminants can infiltrate behind or underneath the cabinets. Any holes such as may occur above the toe space at corners of base cabinets are to be considered during the design and permanently eliminated. Base cabinets are to be sealed to the floor and walls with the appropriate mastic. Openings in cabinet backs are to be neatly fabricated and sealed so that no access to the space between the cabinet back and the wall surface is possible.
5. In laboratory casework, the DP shall ensure installation will not allow any laboratory liquids or water to penetrate beneath cabinet designs. Rubber base is not a waterproofing component. This shall be treated with the same degree of care as that which is used in the design of roofing systems.

DIVISION 07 - THERMAL and MOISTURE PROTECTION

07 00 00 - General Discussion

A. Moisture and waterproofing systems are required at all University buildings.

B. Impermeable moisture barriers are required for all below-grade slabs and perimeter below-grade walls and Vaults.

C. Foundation drainage systems, Mechanical dewatering systems and equipment, damp proofing and/or waterproofing are required at all below-grade walls.

D. The DP shall carefully review these systems with the PM and the appropriate representatives of Facility Management prior to making decisions on systems to be used. These system components work with other penetration sealing devices located in other sections of the DP's specifications and should be thoroughly coordinated.

E. Field fabricated below grade wall penetrations will not be allowed. Manufactured system components like link seals must be specified, detailed and provided.

F. The choice of roofing systems to be incorporated into any building rests solely with the Owner.

G. The Owner will use the opinions of the DP and others in making that decision.

H. The DP is to use all the tools available to him, including the participation by a qualified roofing consultant and the roofing system manufacturers' representatives, to properly define and specify the roofing system to be installed.

I. To expedite the selection of a roofing or waterproofing system, the DP is to establish and conduct meeting(s) with the PM, representatives of the Facilities Management group and others recommended by the Owner.

J. Spray-applied foam roofs will not be allowed on University buildings.

K. All areas of University Buildings that form a barrier between the interior space and the exterior are to be insulated.

L. The DP is responsible for providing an environmentally appropriate system at these locations so that the thermal characteristics of the structure are well considered and that they function together to achieve the intended performance

07 13 00 - Sheet Waterproofing

Description:

This section applies to sheet waterproofing of building vertical and horizontal surfaces. Proper architectural design and detailing of areas backed by sheet waterproofing is expected. This waterproofing is to be the primary barrier to moisture infiltration.

Design Standard:

A. The Design Professional shall specify a 10-year warranty on the material(s) being specified.

B. The DP shall 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.

C. All sheet waterproofing is to be inspected and approved by the manufacturer's representative prior to being covered by subsequent work.

07 21 00 – Insulation

Description:

This section applies to all constructed building vertical and horizontal surfaces that are thermal barriers to the environment. It also addresses demising partitioning acting as acoustical barriers. ASU's goal for new projects is a substantial reduction in energy usage. The Design Professional (DP) is solely responsible for the performance of the resulting insulated assemblies. These are to be designed and constructed as a vital component of the overall Mechanical System selected for the building. The following are areas in which the Owner has specific recommendations:

Design Standard:

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

B. Exterior walls shall attain an absolute minimum R-value of 25.

C. Generally (unless noted otherwise), all corridor, restroom, classroom, laboratory, conference, meeting, lobby, and office walls and ceilings shall be fully sound attenuated. The STC classification of each instance is to be reviewed with the Project Manager (PM) to ensure proper performance of the entire system.

D. Where blanket-type insulation or sound-attenuation material is being utilized in open plenum areas, it shall be:

   1. Unfaced batts if no moisture barrier is required.
   2. Kraft- or foil-faced fiberglass material.
   3. Unfaced fabric-based (denim) insulation batts.

E. Do not specify any form of insulation to be laid directly on accessible ceilings.

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

G. Schedule on-site quality control inspections to check for/assure freedom from heat bridges.

H. Assure that insulation layers are continuous, and without air pockets.

I. Check joint details for air tightness while they are accessible.

J. Have a building shell pressure test performed as part of the building commissioning.

07 24 00 - Exterior Insulation and Finish Systems

Description

This section applies primarily to exterior insulation 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". These proprietary materials are to be designed, detailed and specified in strict conformance with the manufacturer's recommendations. The DP should indicate all required expansion, control, and design joints on the project drawings.

Do not propose an EIFS treatment for areas that are accessible (can be touched) by the public.

Design Standard

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

B. 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.

C. 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.

D. The composite finish system shall consist of synthetic elastomeric primus layer, minimum 3/8-inch thick and an elastomeric synthetic finish layer, minimum 1/16 inch thick.

E. The composite system shall have a reinforcing component such as an embedded fiber mesh as recommended by the manufacturer. This mesh is to eliminate the possibility of underlayment separation and system failure.

07 50 00 - Roofing Systems

Description

This section applies to 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 Design Professional (DP) shall provide sufficient expertise to accomplish this important part of the service or should retain an expert to assist. Roofing shall be done only by a roofer who is approved by the manufacturer whose materials are used. The roofer and manufacturer together will conduct their process so that all aspects of work necessary for the completed system to obtain the necessary bond are properly administered.

Design Standard

A. The roof system and the building walls move independently from each other. The roofing system chosen shall accommodate this movement.

B. The Design Professional (DP), Project Manager and representatives from Facilities Management shall meet at intervals during the selection and design of the roofing system so that all aspects of the selected system are completely understood by all.

C. Roof slope at ASU Structures is to be a minimum of 1/4-inch per foot at the valleys. This applies ultimately to roof valleys and cricketed areas. To achieve this, the general slope of roof planes will exceed this minimum requirement. The DP is required to render this slope accurately and in a technically correct manner so that building perimeter relationships and detailing may be accurately reviewed. The DP is encouraged to render his documents accurately so that the back sides of parapets are clearly and accurately shown.

D. Water shall be directed from the center of a roofed area to the buildings perimeter where water collection is to take place. The DP will specifically avoid sloping roofs to a center collection point from which piping is routed through the interior of the building and underground to daylight. There will be no exception to this requirement.

E. In no instance are rain drain leaders to be installed below slabs inside the perimeter of ASU buildings.

F. Specify primary products, including roofing sheets, as produced and supplied from a single manufacturer as a part of a specific roofing system that the manufacturer will warranty.

G. 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) and that the installer be a part of a manufacturer-sponsored, quality-control warranty program.

H. 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.

I. ASU requires a 20-year warranty/bond on all roofing systems. Only those manufacturers that can comply with this warranty should be specified.

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

Protection of installed material:

A. Membrane roofing is a finish material.

The Contractor is required to protect finish systems from subsequent damage by other trades.

07 84 00 - Firestopping

DEFINITION

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.

GENERAL DESCRIPTION OF THE WORK OF THIS SECTION

A. Firestop system components are extremely critical to the performance of University buildings.

B. The Design Professional (DP) must design and specify technically-correct fire stopping systems to meet each individual condition throughout the project.

C. The services of a consultant may be in the best interests of the DP.

D. It is recommended the DP review proposed locations and materials with the ASU Fire Marshal and representatives of Facility Management prior to finalizing the design.

E. Each system is to represent the most current approved systems and components regardless of guideline suggestions made herein.

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

    1. 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.
    2. Safing slot gaps between edge of floor slabs and curtain walls.
    3. Openings between structurally separate sections of wall or floors.
    4. Gaps between the top of walls and ceilings or roof assemblies.
    5. Expansion joints in walls and floors.
    6. Openings and penetrations in fire-rated partitions or walls containing fire doors.
    7. Openings around structural members which penetrate floors or walls.

THROUGH-PENETRATION UL CLASSIFICATION SYSTEM

Fire Stopping Systems	UL Classification System		
	Construction Penetrated	Type Of Construction Identification	System
1 No Penetrating Items:	F, W, C	A, B, J, K, L	0001-0999
2 Metallic Pipes, Conduit or Tubing:	F, W, C	A, B, J, K, L	1001-1999
3 Nonmetallic Pipe, Conduit or Tubing:	F, W, C	A, B, J, K, L	2001-2999
4 Electric Cables:	F, W, C	A, B, J, K, L	3001-3999
5 Cable, Trays with Electric Cables:	F, W, C	A, B, J, K, L	4001-4999
6 Insulated Pipes:	F, W, C	A, B, J, K, L	5001-5999
7 Electrical Bus duct Penetrations:	F, W, C	A, B, J, K, L	6001-6999
8 Mechanical Ductwork Penetrations:	F, W, C	A, B, J, K, L	7001-7999
9 Multiple Penetrations Through Common Openings:	F, W, C	A, B, J, K, L	8000-8999

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

Fire-Resistant Joint Systems	UL Classification System		
	Joint System	Movement Capability	Joint Width
1 Floor-to-Floor	FF	D	0000-0999
2 Wall-to-Wall	WW	D	0000-0999
3 Floor-to-Wall:	FW	D	0000-0999
4 Head of Wall:	HW	D	0000-0999

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”

INSTALLER QUALIFICATIONS

A. Installers must be experienced, certified, licensed, or otherwise qualified by the fire stopping manufacturer as having been provided the necessary training to install manufacturer's products per specified, and code-regulated, performance requirements.

1. Installation Responsibility: Assign installation of through-penetration firestop systems and fire-resistive joint systems in project to a single, sole-source single, firestop specialty contractor.
2. The work is to be installed by a contractor with at least one of the following qualifications:
    a. Hilti Accredited Firestop Specialty Contractor (HAFSC).
    b. 3M "Master Contractor".
    c. Hilti "Certified Contractor" with current letter from manufacturer.
    d. 3M "Certified Contractor" with current letter from manufacturer.
    e. UL Approved Contractor.
    f. FM 4991 Approved Contractor.
    g. Any other qualifications must be reviewed and approved by the ASU Authority Having Jurisdiction (AHJ) and Fire Code Official.
3. Installing firm must not have less than 3 (three) years' experience with firestop installation.
4. Installing firm must have successfully completed not less than 3 (three) comparable scale projects using similar systems.
5. It is required that the Design Professional and/or his consultant have the expertise necessary to identify, design and specify all aspects of the firestopping process. No attempt has been made here to create a specification.

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.

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

INSTALLATION

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

MARKING AND IDENTIFICATION

A. In addition to code required marking and identification of fire-resistance-rated assemblies, fire-resistance-rated assemblies in non-public spaces that are open from floor-to-ceiling should also include identification consistent with the spacing, lettering and visual requirements outlined in code. Example of such spaces are electrical rooms, IDF/MDF closets, mechanical rooms, etc.

FIELD QUALITY CONTROL

B. Product Manufacturer's Field Services Duties during Installation: provide periodic destructive testing inspections to assure proper installation/application.

C. Product Manufacturer's Duties 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 90 00 - Sealants

Description

This section describes all requirements for sealants to prohibit the penetration of moisture or other contaminants like dust and states the requirement to seal joints between dissimilar materials and 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. ALL INTERSECTIONS between dissimilar materials are to receive a sealant joint treatment that is appropriate for the items in consideration.

   1. Use a performance specification for required sealants. Do not specify proprietary manufacturer’s names or materials. Do not restrict vendors to a limited list.
   2. Specify primary products as produced and supplied from a single manufacturer, which has produced that product successfully for not less than 5 (five) years.
   3. Specify that an approved manufacturer’s installer shall perform the work and have not less than 5 (five) years of successful experience in the installation of caulks and sealants.
   4. Provide a submittal requirement for product compliance, color selection, and samples of sealants used in applicable unique joint conditions.
   5. Maximum allowable exterior joint width for caulking/sealant shall not exceed 1”-inch.
   6. Backing materials shall be a part of a manufacturer's total system for the joint size and type indicated.
   7. DP to specify MATCHING sealant to any selected mortar color in brick or masonry installations. A price increase during construction will not be accepted for a custom matching color. This is required to be a part of the base price. This includes all fire caulking in visible areas (Back of house exempt).

DIVISION 08 - OPENINGS

08 11 13 - 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 is hollow metal, glass, or wood. Knock-down frames are not allowed without specific permission (see “I” below). Double door systems shall have a removable center mullion.

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

The specific Design Standard below has been created as a model for all ASU installations. The Design Professional (DP) is to thoroughly familiarize himself with these guidelines and is to ensure that his finished documents, and field results, reflect these standards. The DP is ultimately responsible for preparing documents in a manner compatible with these requirements and with standards of professional practice.

The DP shall meet with the Project Manager (PM) and representatives of ASU Facilities Management and the ASU Lockshop during the refinement of this section of the DP’s specification.

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 system consisting of primers and paint.

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 glazed openings in exterior steel doors shall use 1 inch insulated wire glass.

I. Timely "knock down" door frames may be used at interior locations with the permission of the Project Manager. However, hollow metal door frames are required whenever door closers are required. See Wood Door Guidelines for framing requirements in those locations.

J. Building floor planning (location and swing of doors, etc.) shall allow for wall space as may be specified to comply with ADA requirements.

K. Door frames are to be installed a minimum of 6" from adjacent walls.

L. Double door assemblies may be provided with removable center mullions. In this instance, the mullion shall be an integral portion of the locking system for the assembly.

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. The following items are of concern to ASU. The Design Professional (DP) is to produce acceptable documents and specifications for a total system.

Design Standard

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

B. Finish: The exposed surfaces color shall be clear unless otherwise specified. Finish shall be with an architectural class anodic coating.

C. Construction and Design: 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 hung, offset pivot, or center hung doors shall have an adjustable integral weather strip.

D. Glazing: Shall be flush, including the horizontal mountings and sills, and held in place with E.P.D.M. glazing gaskets on both 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. Sidelights and/or door lights to be minimum 1/4-inch tempered float, dual pane, 1 inch insulated glass.

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 Americans with Disabilities Act (ADA) specification. The DP shall coordinate closely with the ASU Lock Shop regarding every aspect of hardware to be used on a project.

F. 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).

G. 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 wind load for the Phoenix area. The DP shall ensure the specified components conform to these criteria.

H. Thresholds: Hollow-backed aluminum thresholds have proven unable to withstand the high use of typical ASU doorways. These thresholds deform almost immediately upon installation, sometimes by the Contractor’s own construction practices. The DP shall provide assurance the types of thresholds and their installations are specified so the threshold maintains its profile and properly performs for the expected life of the building.

I. All thresholds shall be set in a mastic system so that absolutely no water or air infiltration is possible from one side of the doorway to the other.

08 14 00 - Wood Doors

Description

This section applies to interior applications. 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 with wood doors. Double door systems shall have a removable center mullion.

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.

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

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.

G. Doors and frames shall have a spray-applied finish.

H. 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. The Design Professional (DP) is expected to evaluate curtain wall locations as an integral part of the overall building environmental performance profile. Environmental awareness and sustainable factors shall guide the DP in the use and location of these systems.

Design Standards

A. The DP shall specify that a fabricator/erector shall have a minimum of 5 (five) years' of 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 at an absolute minimum.

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

D. "Kynar 500" or equal shall be specified for painted finishes. This is a factory applied baked enamel. It is part of the manufacturer's guarantee.

E. Locally-applied painted finishes or powder coating shall not be acceptable in a manufactured "system".

F. Powder coating, or a professionally applied paint, coating may be acceptable if the nature of the curtain wall and its custom fabrication is not backed by a manufacturer's warranty.

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

H. 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.

I. 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.

J. In areas where the interior clear height of curtain walls, storefront system, or any fixed glass that will require periodic maintenance, exceed 30' (possibly an atrium), a permanent system(s) must be designed to facilitate window washing without the use of erected scaffolding or movable lifts.

K. On buildings that exceed 3 (three) stories or 30' from finish grade, an exterior window washing system shall be designed and permanently installed.

L. The window washing accommodation aspect of the design shall be coordinated by the DP and designed with the full assistance of the Facilities Management (FM) Department group responsible for maintaining the appearance of the glazed system. The DP is to assure that FM approves the system prior to completion of the documents and specifications.

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." Please seek guidance from Lock Services for specific hardware requirements.

Design Standard

A. Hardware suppliers shall be specified as having a minimum of 5 (five) 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 Services will determine hardware manufacturer, NOT the design/architecture firm.

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

D. Door closures shall carry a minimum 35-year warranty from the manufacturer against failure or leakage.

E. Latchsets, locksets, hinges, panic devices, cylinders and holders shall carry a written minimum 10-year warranty from the manufacturer against failure. Hardware containing plastic parts are not acceptable.

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

G. Mortise locks are not acceptable. Unless specifically approved by Lock Services.

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

I. ASU supplies the final key cylinder, All hardware must be compatible with SFIC (small format interchangeable cores), to be funded by the project.

J. Doors shall have a minimum of 3 heavy duty type institutional hinges per door, Ex: BEST FBB168.

K. All exterior doors shall have thresholds, closures, weather-stripping 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. Required pads and installation shall meet ANSI and ADA requirements and criteria.

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

N. Restroom Entrance Doors:

   1. **Doors shall open outwards.**

   2. Provide push panel on inside, pull handle on outside.

   3. No latching bolt mechanisms shall be provided unless required by Code.

O. The following manufacturer's and hardware type are acceptable at ASU and is an example of the level of quality typical required by the owner: Contact Lock Services to verify specific requirements at the various campuses.

   1. Door locks: cylinder lever type locks, Best 9K series whenever possible. Consult Lock Services.

   2. Dead bolts: heavy duty auxiliary type (SFIC), BEST 8T series.

   3. Panic devices, with lever night-latch function trim, single door, narrow style: Single door standard: Von Duprin 99, rim type; Von Duprin 3327, 9927. Single door narrow style: Von Duprin 33 rim

type. Double door standard: Von Duprin 99, rim type with lever night -latch function trim and removable keyed mullion.

4. Doors with external vertical rods will not be permitted.
5. Surface-mounted closures: EHD9000 SPA90 or SDS90-or LCN 4040 door closer (except where and existing HDCP had been installed). No in-floor door closures will be permitted.
6. Manual flush bolts: Trimco.
7. Magnetic holders: ABH Mfg.

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 Services.

S. Laboratory Electronic Locks: These are a special application that will be designed in conjunction with CPMG and the appropriate authority. ASU Lock Services will approve all hardware prior to purchase and installation.

08 79 13 – Key Control Cabinets

Description

ASU requires a Key System Cabinet to be included in all building projects. This includes New Construction, Major Remodels, or Building Re-Keys. Sammy Kent is the FM Supervisor for the ASU **Lock Services** and should be consulted at the early stages of design to ensure standards have not been changed.

Design Standard

A. All new projects/remodels/re-keys must go through Jennifer Gorney and/or Sammy Kent.

1. As areas are remodeled/renovated ASU is migrating to small format interchangeable cores (SFIC). Please ensure all doors are prepped for SFIC.
2. Key (SAM) Boxes will be installed during all remodels. Lock Services will order the boxes for you and deliver the box to your contractor to install:
    i. Boxes weigh 123lbs without keys and close to 200lbs with keys. Mounting into drywall alone is not acceptable.
    ii. Electrical requirements: 110 – 240 VAC, 47 – 63 Hz 2 Amps, 300 Watts. Typically (1) 120VAC power receptacle will work.
        a. Data requirements: standard data drop on the Secure VRF VLAN for the building. I believe that is either VLAN 3600 or 3620, along with a static IP which should fall somewhere in the 10.172.xxx.xxx range. Once we have the static IP assigned BFIT can go to Firewall and the Palo Alto team for the rules to allow communication (1 ea. Cat 6 data cable is needed for network connectivity).
        b. Both pathways enter through the bottom of the box. There is a small ¾” knock-out for power in the illustration. A 1” conduit is needed for data which may require an opening with a Greenlee knockout. Power can be hardwired once the panel is installed; you can route inside the cabinet and use a SMB if needed.
        c. We recommend the largest box available, which currently is a 96 count box. Typically we recommend one box per building unless it has multiple wings/main entry points or has a high department/building occupant load; these jobs will be handled on a case by case basis.
        d. We will not mount boxes on an exterior wall due to the heat exposure. Hallways,

   vestibules, or interior room next to the loading docks that may work as long as it's conditioned space (Hayden Library is an excellent example).
   e. As you discuss how card readers will be integrated going forward, please keep in mind card readers are required on all building entrances and any room that's designated as a classroom. No keys will be issued to ISAAC doors, however, we will have access keys within the Key Box.

3. The cabinet must be installed to meet ADA Reach Requirements: ADA regulations: 15" Min. - 48" Max Reach Range to the highest row of keys AND/OR operable components.
4. The cabinet must be surface mounted but since it is 6" deep there must be a pedestal built out below to meet ADA Requirements for visually impaired persons. The doors will require a 180˚ swing (from right to left). Please refer to pictures of cabinets installed at USB.
5. The ASU Lock Shop will approve the final location (See attached sample drawing for possible locations and why they were excluded and why the ideal location was selected.) The Lock Shop will also confirm the correct size and quantity of boxes for your building. Keep in mind for each box you will need (1) 120VAC power receptacle and (1) Cat 6 data cable for Network Connectivity. If a second cabinet is required the power can share the same power circuit but each box has to have its own receptacle and its own back box for data.
6. Vendors are now required to carry 'University Vendor' SUN Cards with their picture. I've outlined the steps below and have attached the Courtesy Affiliate Request Form.

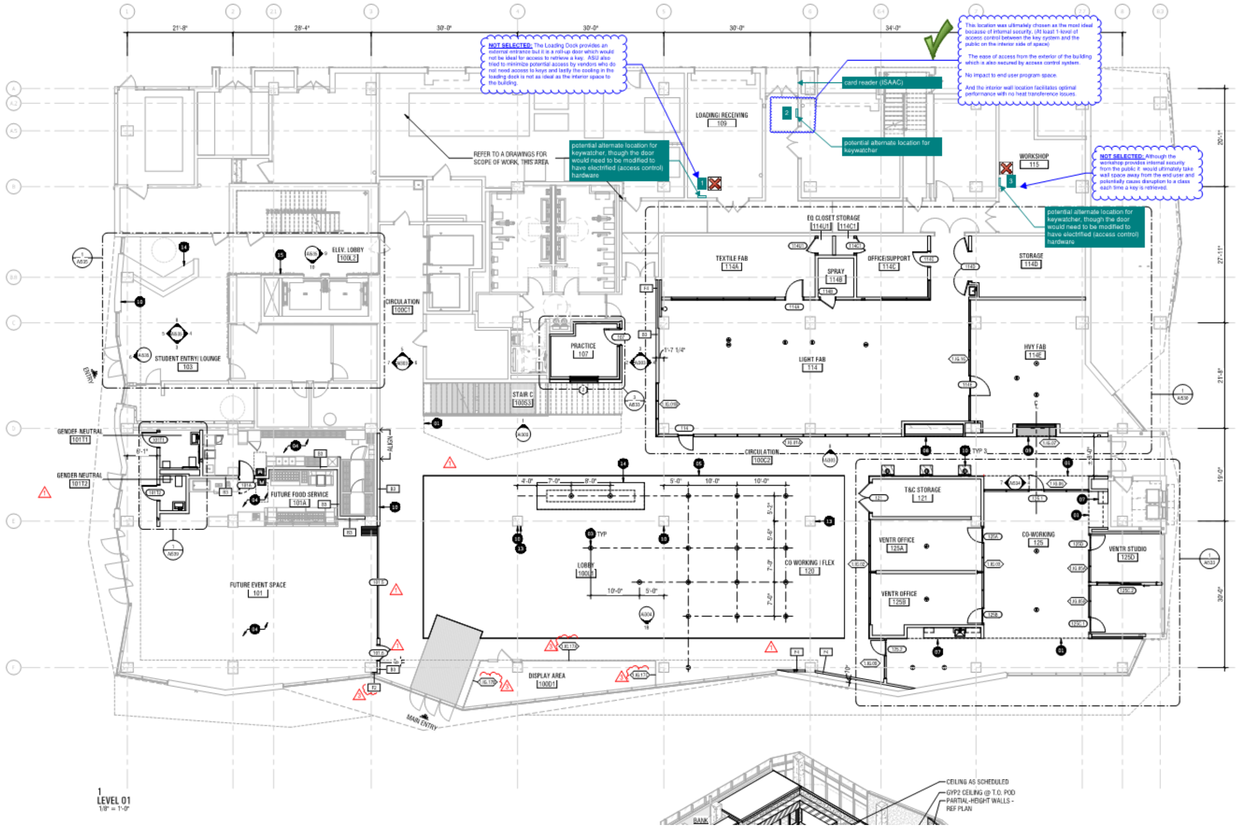
Vendor Card/Key Access Process

A. Customer completes Courtesy Affiliate ID form online: https://asu.service-now.com/sp?id=sc_cat_item&sys_id=bc79f2ebe1bea10047cd75a5d1bde091 Choose **NVEN** as the affiliation option.
B. ET creates a PeopleSoft record with the NVEN designation*
   a. Courtesy Affiliate ID is emailed to customer
C. Customer follows auto-generated email instructions to create an ASURITE ID and password
D. Customer goes to the Tempe SUN Card office to obtain University Vendor ID card and pay the $25 fee (credit/debit card).**
   a. If you are unable to visit the Tempe Campus location, submit your photo and verification ID online https://webapp4.asu.edu/cardservices/. You will be required to authenticate with their ASURITE login and password.
   b. Once approved the SUN Card office will print the badge and sent it via intercampus mail to a satellite location where you can then pick it up and pay the $25 fee (SUN Card satellite locations are at Downtown, Polytech and West Campuses: https://cfo.asu.edu/cardservices#fees-and-location
E. Customer or Sponsor submits a Facilities Service Request for either physical keys or key system (SAM Box) access: https://links.asu.edu/FDMServiceRequest.***
   a. Choose Key Systems (GFMS) from the drop-down menu and fill in your information
   b. The Authorizer is the Dept. Dean/Chair/Director/VP
   c. Sun Card RFID is the five or 6 digit number on the back of your Vendor card following + or * symbol.
   d. Once you get your receipt with your request number, forward that email to Facman@asu.edu and include a picture of the back of your SUN Card.
   e. FACMAN will notify you when your access is granted.
F. Customer or Sponsor submits a Service Now ticket for ISAAC access:
https://asu.service-now.com/sp?id=sc_cat_item&sys_id=69d56fb4a4c33100e033b7890dec9ad3
   a.
   b. *If you have questions regarding the form or did not get an immediate email response from ET please call them at 855-278-5080 or reach out to them via live chat:
   c. https://contact.asu.edu/?parature_id=8373-8193-4742
   d.

e. **if you already have a SUN Card with University Vendor on it just forward Facman@asu.edu your confirmation email that your affiliation has been extended. Mark the email to Melanie and my attention please.
f.
g. ***if you have a SUN Card and SAM Box keys already set up just forward Facman@asu.edu your confirmation email that your affiliation has been extended. Mark the email to Melanie and my attention please.

PACKAGE INCLUDES THE FOLLOWING DOCUMENTS:

- Example drawing of potential locations and selection criteria. (1-pg.)
- Photo – Front View of Key System Cabinet at USB (1-pg.)
- Photo – Side view of Key System Cabinet at USB (1-pg.)
- Photo – Secondary Cabinet at USB (1-pg.)
- Dimensioned Drawing – Keylock Box Mounting Information
- Dimensioned Drawing – 96 Count Key System Cabinet



NOT SELECTED: The Loading Dock provides an external entrance but it is a roll-up door which would not be ideal for access to retrieve a key. ASU also tried to minimize potential access by vendors who do not need access to keys and lastly the cooling in the loading dock is not as ideal as the interior space to the building.

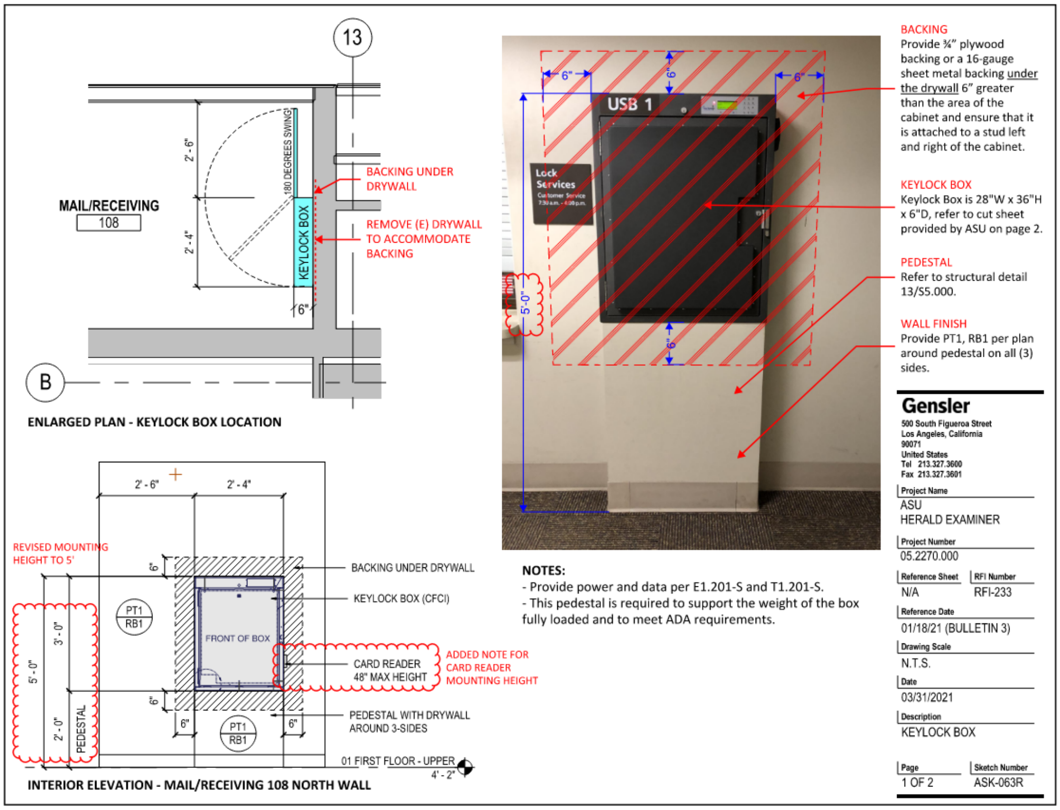
This location was ultimately chosen as the most ideal because of internal security. (At least 1-level of access control between the key system and the public on the interior side of space)

The ease of access from the exterior of the building which is also secured by access control system.

No impact to end user program space.

And the interior wall location facilitates optimal performance with no heat transference issues.

NOT SELECTED: Although the workshop provides internal security from the public it would ultimately take wall space away from the end user and potentially cause disruption to a class each time a key is retrieved.



BACKING
Provide ¾" plywood backing or a 16-gauge sheet metal backing under the drywall 6" greater than the area of the cabinet and ensure that it is attached to a stud left and right of the cabinet.

KEYLOCK BOX
Keylock Box is 28"W x 36"H x 6"D, refer to cut sheet provided by ASU on page 2.

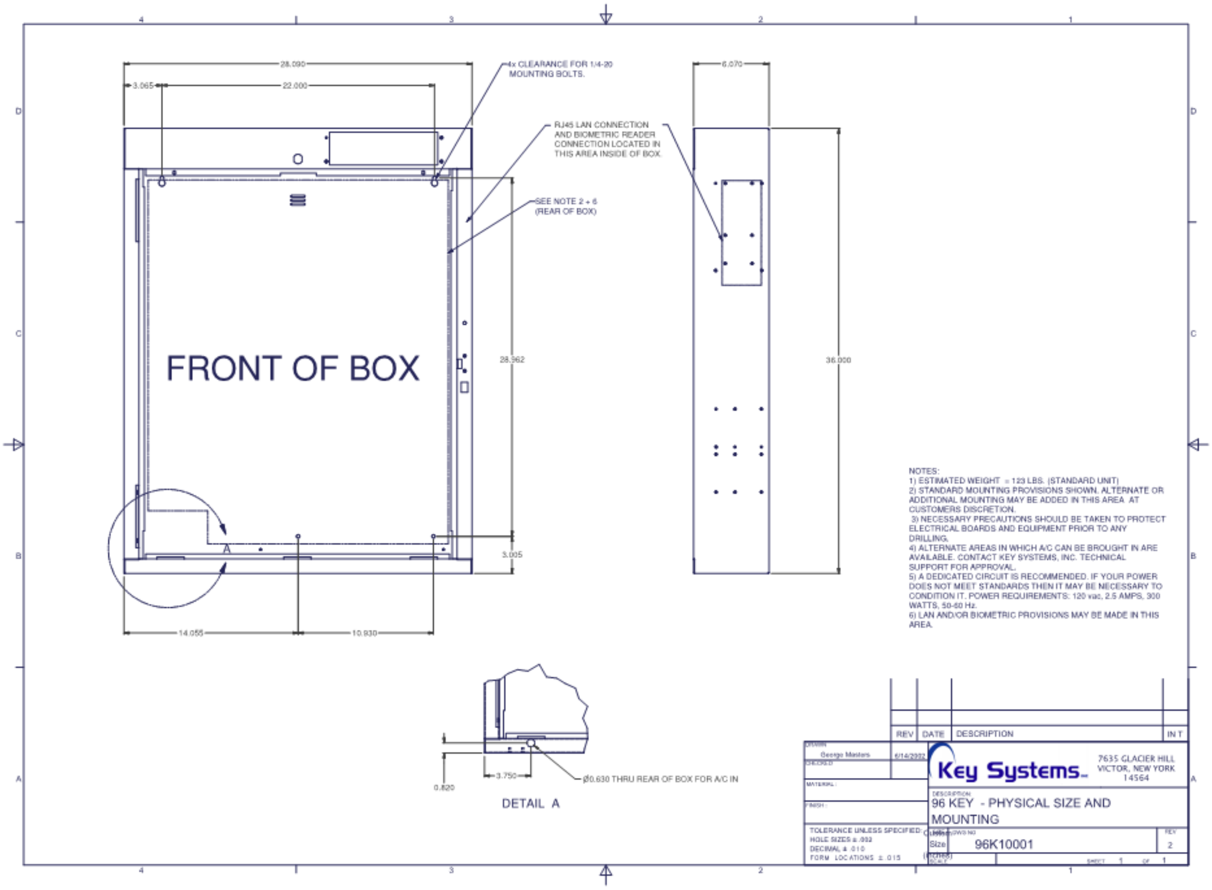
PEDESTAL
Refer to structural detail 13/S5.000.

WALL FINISH
Provide PT1, RB1 per plan around pedestal on all (3) sides.

NOTES:
- Provide power and data per E1.201-S and T1.201-S.
- This pedestal is required to support the weight of the box fully loaded and to meet ADA requirements.

Gensler
500 South Figueroa Street
Los Angeles, California
90071
United States
Tel 213.327.3600
Fax 213.327.3601

Project Name ASU HERALD EXAMINER	
Project Number 05.2270.000	
Reference Sheet N/A	RFI Number RFI-233
Reference Date 01/18/21 (BULLETIN 3)	
Drawing Scale N.T.S.	
Date 03/31/2021	
Description KEYLOCK BOX	
Page 1 OF 2	Sketch Number ASK-063R



NOTES:
1) ESTIMATED WEIGHT = 123 LBS. (STANDARD UNIT)
2) STANDARD MOUNTING PROVISIONS SHOWN. ALTERNATE OR ADDITIONAL MOUNTING MAY BE ADDED IN THIS AREA AT CUSTOMERS DISCRETION.
3) NECESSARY PRECAUTIONS SHOULD BE TAKEN TO PROTECT ELECTRICAL BOARDS AND EQUIPMENT PRIOR TO ANY DRILLING.
4) ALTERNATE AREAS IN WHICH A/C CAN BE BROUGHT IN ARE AVAILABLE. CONTACT KEY SYSTEMS, INC. TECHNICAL SUPPORT FOR APPROVAL.
5) A DEDICATED CIRCUIT IS RECOMMENDED. IF YOUR POWER DOES NOT MEET STANDARDS THEN IT MAY BE NECESSARY TO CONDITION IT. POWER REQUIREMENTS: 120 vac, 2.5 AMPS, 300 WATTS, 50-60 Hz.
6) LAN AND/OR BIOMETRIC PROVISIONS MAY BE MADE IN THIS AREA.

Key Systems GFMS www.keystorage.com

Technical Support
Email: techsupport@keystorage.com
Phone: (585) 924-7810

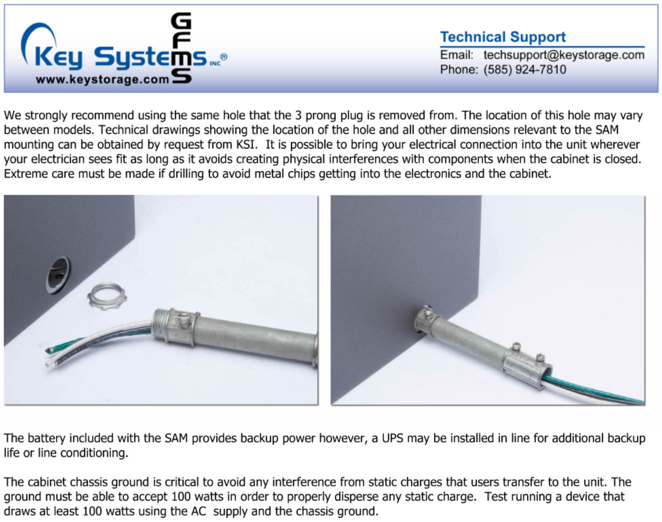
SAM AC Power Connection

Your Security Asset Manager (SAM) is powered by an internal AC/DC switching power supply with an input rating of 100--240 VAC, 50/60Hz, 1.4A. and an output of 24 volts DC. This is connected through a junction box to a 3 prong AC power cord attached through the back left corner of the unit.

The 3 prong power cord is meant for bench testing. Although it could be used as the permanent power connection KSI strongly recommends that all SAMs be hardwired.

In order to hardwire the SAM follow these steps:

1. Open the cabinet and locate the power junction box in the bottom left corner.
2. Remove the two screws from the top and then remove the cover plate to gain access to wire connection.
3. Disconnect the 3 prong AC power cord and remove it.
4. In it's place, connect directly to your AC circuit in a manner to meet all applicable electrical codes.



Key Systems GFMS www.keystorage.com

Technical Support
Email: techsupport@keystorage.com
Phone: (585) 924-7810

We strongly recommend using the same hole that the 3 prong plug is removed from. The location of this hole may vary between models. Technical drawings showing the location of the hole and all other dimensions relevant to the SAM mounting can be obtained by request from KSI. It is possible to bring your electrical connection into the unit wherever your electrician sees fit as long as it avoids creating physical interferences with components when the cabinet is closed. Extreme care must be made if drilling to avoid metal chips getting into the electronics and the cabinet.

The battery included with the SAM provides backup power however, a UPS may be installed in line for additional backup life or line conditioning.

The cabinet chassis ground is critical to avoid any interference from static charges that users transfer to the unit. The ground must be able to accept 100 watts in order to properly disperse any static charge. Test running a device that draws at least 100 watts using the AC supply and the chassis ground.

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.

Select glazing size and materials appropriate for the orientation of the windows. Use double or triple glazing wherever possible. Thermal breaks shall be included in window frames at all exterior glazing.

Design Standard

A. Dual pane, 1 inch insulated glass on all exterior windows and doors. 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 1/4-inch tempered float, dual pane, 1 inch insulated 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 CPMG.

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 (three) 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 weather-stripped and gasketed.

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

K. **Sidelights** - Glass located at the latch side of doors shall be a minimum of 18" wide. 18" of glass (not including mullions) is required to provide an ADA compliant, serviceable location for room identification signage.

L. All exterior Aluminum Storefront assemblies set on floor slabs shall utilize a sub-sill assembly set in a bed of sealant to prevent moisture infiltration at any base conditions.

Figure 08-80-00 K.01 Sidelights at Latch Side of Door

08 87 00 - Glazing Surface Films

Description

This section provides insight into the appropriateness of various aspects of the installation of window films at both new and existing buildings on all campuses.

Design Standard

A. The ASU desired performance criteria is to be established on a job-by-job basis incorporating the needs of the customer, the Project Manager (PM), the Design Professional (DM) and the manufacturer of the film. Each individual application serves to address a specific need. It is important that the manufacturer be involved so that no product is selected for an inappropriate application.

B. Spectrally-selective window film: These products are recommended by the manufacturer and selected by the Design Professional or Project Manager so that a specific need or shortcoming of the existing or new window glazing can be resolved or reduced.

C. Solar Properties (based on application to single-pane clear).

   1. Min. 60% VLT (visible light transmittance).
   2. Min. 60% TSER (total solar energy rejected).
   3. Max. 10% VLR-E (visible light reflectance: exterior).

4. Max. 0.35 SHGC* (solar heat gain coefficient).
5. Min. 1.00 luminous efficacy ratio.

D. While it is imperative that the manufacturer assist in meeting the specific goals of all installations, the following is provided for information purposes. As a minimum, applied films are to meet the following requirements:
   1. Spectrally-selective window film preferred.
   2. Solar Properties (based on application to single-pane clear).
      a. Min. 30% VLT (visible light transmittance).
      b. Min. 45% TSER (total solar energy rejected).
      c. Max. 20% VLR-E (visible light reflectance: exterior).
      d. Max. 0.35 SHGC* (solar heat gain coefficient).

E. For (existing) tinted glass, or glass with a pre-existing film.
   1. Spectrally-selective window film preferred.
   2. Solar Properties (based on application to single-pane *tinted*).
      a. Min. 20% VLT (visible light transmittance).
      b. Min. 60% TSER (total solar energy rejected).
      c. Max. 20% VLR-E (visible light reflectance: exterior).
      d. Max. 0.40 SHGC* (solar heat gain coefficient).

F. *Reference IECC for maximum SHGC assembly rating.

G. Requirement for Manufacturer's Certification of installers.
   1. Only teams comprised of the manufacturer, the installer and specifically the installation labor force are to be utilized in film application work.
   2. The manufacturer must have a training and certification process in place.
   3. The Installer must show proof that the installation firm is a certified installer of the product and proof that each worker has likewise been properly trained and certified by the manufacturer.
   4. This relationship also creates warranty assurances described elsewhere in this section.

H. **Decorative Interior Films**
   1. There are a great variety of window film products offering design oriented options to interior glazes systems.
   2. These products may be selected for aesthetic purposes or for enhancing aspects of the film that may provide a degree of privacy. Selections are to be made based on the Manufacturer’s recommendation and the DO/OUA/PM goals.

I. Interior Window Film Design Guidelines

Description:

The Interior Window Film Design Guidelines are intended to provide guidance to the design professional (DP) as well as internal ASU stakeholders on the design, look, placement, and other such aesthetics of interior window film applications.

Each project and end user situation is unique and these Guidelines provide direction and a framework for the design team and ASU agents to work within to achieve the project goals as well as align with the University's design goals and aspirations as set forth by our CFO and the University Architect.

The goal of these guidelines is to expedite the project schedule while maintaining University standards. Exceptions to any design standard may be discussed with the University representatives as appropriate.

Design Standard:

A. The desired aesthetic is a plain, sandblasted or etched glass finish providing privacy while enabling lighting transfer and visual connection into enclosed spaces
    1. Examples of appropriate applications include, but are not limited to:
        a. Conference rooms with large glass areas that open to hallways, walkways, or open office spaces
        b. Private office side lights
        c. Enclaves
        d. Classrooms with large glass areas in student or instructor line of sight

B. Product should have a permanent, pressure-sensitive acrylic adhesive

C. Product should have Class A rating per ASTM E84 Test method as defined by NFPA 101 Life Safety Code

D. Product should be compliant as low emitting and in compliance with the General Emissions Evaluation (California Department of Public Health (CDPH) Standard Method V1.1-2010)

E. Installation method should be wet application with air and application surface temperature between 54˚F-100˚F

F. The typical installation height shall be 7'0" starting at 2'0" AFF

G. Installation should allow for light transfer and occupancy awareness but provide for privacy and minimized visual distraction for occupants

H. The DP or Contractor shall submit proposed product specification, colors, samples and specific application details to the Office of the University Architect for approval. In addition, any text, design or graphic integration needs additional review and approval by ASU Marketing Hub.

I. **Anti-Graffiti Films**
    1. Essentially anti-graffiti films are specified at the exterior side of glazed areas that are subject to spray painting or other vandalism.
    2. It is important that the selecting party have the manufacturer's data and works with the manufacturer to select the appropriate product.
    3. When the vandalism occurs the existing film is removed and a new film is installed.
    4. These films are somewhat resistant to the act of diamond etching a pane but it will not protect from cutting that may occur.
    5. The warranty for the film and labor is the same as for other applications with the exception that it will not address periodic replacement based on vandalism.

J. **Security Films**
    1. Security films are available to help to reduce the potential for a glass opening to be smashed out providing access to the interior of the facility.
    2. These films are applied to the vulnerable side of the glazed opening, usually on the exterior side.

3. When an attempt is made to smash the glass, the film adheres to the glass pieces and prohibits them from breaking loose and leaving the opening unobstructed. These films are very strong and difficult to break through.
4. There is no currently available bullet resistant film product made. If this is a criterion for the location, it is suggested that the installation be provided with appropriate glass or plastic material.

K. **Films in new construction**

1. There are a few select instances where it may be appropriate to apply appropriate films to glazed areas in new construction.
   a. The glass should always be selected based on all the performance criteria and engineering that new glass carries with it.
   b. It is possible for interior and exterior films to further enhance the performance characteristics of the glass material. For instance, if the thermal calculations come up lacking even though the most appropriate glass is specified, having a film applied in the field or directly at the manufacturing site may provide beneficial performance,
   c. This should always be considered with the direct involvement of the glass Manufacturer and the film manufacturer.
2. It is possible that additional LEED points may be obtained.

Interior vs. Exterior Application:

A. Exterior window films are manufactured to address very precise desired performance characteristics. These are to be selected only with the involvement of the Manufacturer. The warranty for an exterior application must include:

1. Manufacturer’s 5 (five) year written warranty for the material.
2. Installer’s warranty on workmanship for 2 (two) years in accordance with A.R.S. requirements.
3. A material warranty providing for glazing replacement in the event that the glazing destruction is caused by the film.
4. These warranties may be from the individual parties or may originate with the manufacturer covering all listed items.

B. Interior glazing films are to be provided with a 15 year material and workmanship warranty only. These films present a negligible danger of breakage due to thermal shock.

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 inch centers to a maximum height of 12 feet. Minimum 20 gauge galvanized metal framing on 16 inch centers to be provided where wall heights exceed 12 feet.

B. Provide full height (to structure) studs at door and window jambs.

C. Provide diagonal stud bracing to structure at 48 inches on center (staggered) where partitions terminate at or slightly above the lay in acoustical ceiling grid.

D. 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 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 1/2 " tall sheet metal 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.
   4. Provide engineering for built up headers made of light gauge metal framing.
   5. Provide built up members at corners, jambs and other locations where stresses are enhanced.

9 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 products and finish levels shall adhere to code requirements unless noted otherwise.

C. Provide Level 4 "Smooth" finish typically throughout.

D. Walls that are to receive "Walltalker" finish and other special areas as determined by the Design Professional (CP) shall receive Level 5 finish.

E. No ½ inch thick gypsum board is to be used at ASU.

F. All Gypsum Board shall be minimum 5/8" thick with a fire-rated skin.

G. All Gypsum Board in all areas of toilet rooms and other areas where moisture will be present in any form will be mold resistant.

H. Related types of hardboard material applied to metal studs will be selected to adequately meet the requirements of the intended use and shall be used strictly in accordance with the manufacturer's recommendations. An example of this material is hardboard cementitious-based tile backer.

09 30 00 - Tile

Description:

This section applies to interior and exterior areas using ceramic tile for floors, walls, countertops, wraps and architectural design accents. Specific manufacturers 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 Professionals (DP) should be prepared to present physical tile samples to the Office of the University Architect (OUA) for review and approval.

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.

  1. In pertinent applications, Dynamic Coefficient of Friction (DCOF) AcuTest values should be supplied with specification (ANSI A137.1 Section 9.6).

B. Minimum floor tile dimensions shall be 8 inch x 8 inch, matte finish (abrasive finish if exterior or lobby applied), and comply with the following requirements:

  1. Through color preferred, 3/8 inch minimum thickness.
  2. Cove tile bases and all available additional accessory tiles shall be used in all restroom applications.
  3. Tile inserts or accents in a predominantly matte 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, thin-set on proper backing. Tile shall be full height on the wet wall(s) with a tile wainscot on remainder.
     a. Complex or intricate patterns or designs should be avoided.

D. Grout joints should not exceed 1/16 inch.

  1. A color of tile and grout should be chosen that is easily maintainable.
     a. White or light-colored grouts should be avoided.
  2. 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.
  3. 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.

E. An additional 2% tile shall be provided for maintenance stock.

F. All installations shall be per the manufacturer’s recommendations of the products to be used.

  1. Installations shall comply with the Tile Council of America (TCA) Handbook for Ceramic Tile Installation.

G. All preparatory work is to be accepted by the subsequent trade prior to beginning work of that trade.

H. All workmen are to be properly skilled and knowledgeable in their area of work.

I. The Contractor shall properly coordinate and plan the work so that the tile modules and DP Designs are preserved throughout the construction process.

J. All grout is to be sealed prior to final inspections.

K. Caulk joints shall be sealed per the USG and TCA where tiles intersect dissimilar backings.

L. Fully protect all tile areas from completion until Owner’s acceptance of the structure or area.

M. Kraft paper is not considered protective in this instance.

  1. Carefully protect corners and exposed edges.

09 51 00 - Acoustical Ceilings

Description:

This section applies mainly to suspended acoustical tile ceiling applications. The Design Professional (DP) shall carefully create a composite-reflected ceiling plan that accurately shows all proposed ceiling-mounted items including the location of all lighting fixtures, diffusers, audio/visual equipment and sprinkler heads. 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 square type edges.

B. Minimum NRC factor:

  1. Where Noise Reduction is critical: NRC 0.80+
  2. Classrooms: NRC 0.70 - 0.79
  3. Enclosed Offices, Open Office Areas, Conference and Meeting Rooms: 0.60+
  4. Back of House Utility Areas and Circulation Areas: 0.50+

C. Concealed spline systems are not acceptable.

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

E. Suspension grid to be exposed, Heavy Duty T type.

F. Lighting, diffusers and sprinklers shall be designed to occur in the system at regular or predetermined intervals. They are to be located in the center of ceiling tiles.

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

H. Maintain a 6" minimum clearance between the top of the grid and all other systems installed above the ceiling. **DP is responsible for coordinating the agreed ceiling height per the design with any and all Structural, HVAC, Electrical, AV or fire protection component prior to construction. Lowering of the ceiling to achieve the clearances during construction is not acceptable.**

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

J. Limit ceiling tile types to one per space, and no more than 3 (three) per building.

09 63 40 - Stone Flooring

Description:

Stone flooring must be chosen for its long wearing abilities as well as appearance. The Design Professional (DP) must prove that this selection is appropriate and must be knowledgeable regarding cleaning and maintenance. The DP must support this design formally to the PM before including stone materials in the project.

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 shall be avoided due to maintenance difficulty and product instability.

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 four (4) tiles on other panels smaller than 48 inches.

F. All stone flooring as well as all grout joints are to be sealed and waxed as a part of the construction process. The DP is to confer with the Project Manager and the University Janitorial Services Group to determine the correct materials to be used in this final preparation before turning the facility over to the Owner.

09 65 00 - Resilient Flooring

Revised 2019

Description

This section includes Vinyl Composition Tile (VCT), Luxury Vinyl Tile (LVT) and plank, rubberized flooring tile and rubber base. Design Professional (DP) shall be prepared to present physical tile samples to the Office of the University Architect (OUA) for review and approval.

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. LVT required specifications:

  1. Minimum .05mm (20mil) wear layer – 0.7 (30 mil) wear layer preferred.

  2. Meet or exceed performance requirements of ASTM F 1700, Standard Specification for Solid Vinyl Floor Tile.

    a. Smoke density not more than 450 per ASTM E 662; Passing qualifications on: Static Load per ATM F970, Dimensional Stability per ASTM F 2199, Chemical Resistance per ASTM F 925.

  3. Square-edge detail preferred; Slight bevel acceptable in smaller quantity applications.

  4. Floorscore® Certified materials preferred.

  5. 10-year commercial warranty minimum.

  6. Direct glue-down installation preferred. Other installation methods such as click or snap method acceptable where deemed appropriate by site or project specific conditions (as determined by project ASU Project Manager and Office of the University Architect (OUA) and representatives).

D. A color should be specified that is easily maintainable. Whites and uniform solid colors are to be avoided.

E. Floor preparation is to be done by the tile subcontractor and is to reflect the manufacturer's recommendations.

F. Specify 4 inch x 1/8 inch coved rubber bases, dark in color with matte finish.

G. Specify pre-formed inside and exterior corners only. Field fabrication is not acceptable.

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

I. Specification should call for (1) one box per 50 or any fraction thereof additional material for each color, pattern or type used.

J. Specify that the Contractor is to finish the VCT prior to final inspection.

  1. Strip the new tile surface per the manufacturer’s recommendations.
  2. Apply at least two coats of wax per the manufacturer’s instructions. This wax is to be power buffed and is not to be a liquid-applied, no buffing, non-wax coating.
  3. Final waxing shall be per the Manufacturer’s recommendations and the products and practices of the ASU Facilities Maintenance Department.
  4. The DP must verify these products and practices and insert these instructions into the project specifications.
  5. In the event that the waxing reveals defects or contaminants underneath the tile, the tile is to be removed and the defect corrected. All of the above cleaning and polishing steps must be applied to the replaced area until it appears identical to the remainder of the floor.

09 68 00 - Carpet and Carpet Tile

Description

ASU procures carpet materials directly, using statewide purchasing contracts. All carpet goods and services are to be procured using this procedure. The ASU carpet goods buyer will assist the Design Professional (DP) in understanding the types of materials and products that are available and will ultimately purchase and have the material installed. The DP is to coordinate the particular requirements of the project with the Project Manager (PM) and Carpet Buyer so that the process is correctly administered. There will be no exception to this requirement. The DP will indicate in his documents that the Contractor is to be aware of, and is to coordinate all activities of this Owner-provided item. He is to provide overall coordination and ultimately be responsible for the maintenance of his overall construction schedule. To do this, the DP and Contractor will need to work carefully with the Owner throughout the process.

DP is to propose carpet in appropriate areas of the project. 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-prone areas.

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

The vendor of any flooring product procured shall be required by contract to take back at the end of its useful life and provide documentation of re-use or recycling of the supplied product. ASU will ensure that the product is removed, packaged on palettes, and made available at the building dock or service entrance for pick-up.

Design Standard

A. Seek guidance from the appropriate ASU group regarding specific carpet products to be used for a specific project.
   1. Specific product specified is required to meet or exceed product requirements called out in purchasing floor covering contract.
      a. Specifically, warranty requirements, product performance specification, and manufacturer business requirements, as called out by purchasing, need to be considered.

B. Specify extruded or molded rubber carpet edge guards and/or transitions at flooring material transitions. Metal transitions also are also acceptable.

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

D. 4 inch x 1/8 inch coved rubber bases, dark in color, matte finish with preformed inside and outside corners is required.

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

09 69 00 - Access Flooring

Description:

The decision to utilize an access floor system is usually a strict program requirement. The Design Professional (DP) must prove the capability to design and specify this technology accessory or the DP is to retain the services of an access floor consultant who is independent and not affiliated with any one manufacturer. The DP must understand the customer’s needs and the ability of the different systems to accommodate them. Use of this type of system requires extremely careful coordination between the disciplines: mechanical, electrical, IT as well as others. Verify with Users whether or not an existing system is currently in place. If so, make all efforts necessary to ensure compatibility with existing systems.

Design Standard

A. Design appropriate structural capacity. 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. Verify the systems' lateral stability. 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. Verify the desired electrical conductivity of the system. Not more than 10 ohms resistance between panel and under structure. Verify requirement for grounding of the system. Verify access systems may require electrical grounding.

D. Many different types of panel construction are available. Each has differing characteristics. ASU has experience with Panels that are 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. It is recommended that the DP, Project Manager (PM), and the customer all review an existing installation of the recommended system.

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. The DP and its Consultants are to address the possibility for water infiltration below the access floor system and must consider this eventuality in their designs for the under floor area.

G. Spaces below access floor systems are subject to the requirements of the Fire Marshal. Properly coordinate any such concerns during schematic design and refine these aspects of the system through the completion of the construction documents.

H. Carpet and tile finishes that are applied to an access floor system may be provided and installed under the ASU state purchasing agreements. DP and PM are to coordinate this aspect of the project early in schematic design.

09 72 00 - Wall Coverings

Description:

Application of Wall Coverings is discouraged because of difficulties in maintainability and repair when damaged, as well as fire protection/safety concerns.

Refer to Classroom Design and Technology Standards document for wall protection application suggestions in classroom settings.

09 91 00 - Paint

Description:

This section applies to exterior and interior areas or surfaces that are to receive a painted final finish. Large areas of painted exterior surfaces exposed to view and sunlight should be avoided due to the annual or biannual cost of maintenance. Paint products scheduled for exterior application must be evaluated for colorfastness. Painted exterior features exposed to view that are generally inaccessible without special scaffolding or working platforms should also be avoided.

The Design Professional (DP) is to confer with the Project Manager (PM) and the Facilities Management (FM) paint specialists regarding University-wide standards of materials, systems and colors. ASU appreciates a degree of standardization of paint colors due to the huge extent of painted surfaces and our commitment to maintenance. The DP must understand that proposing a host of special colors for this project is not a long-term solution.

No attempt is made here to list or enumerate aspects of painting that should be thoroughly understood and present in the work of the DP. The following are specific considerations regarding painting that ASU would like the DP to take into consideration when specifying his painting systems and products.

Design Standard:

A. All painting materials are to be selected from the product lines of one manufacturer unless special conditions require another manufacturer.
  1. Each specific coating is to be comprised of an integrated system of preparation, primers and finish coats.
  2. The manufacturer’s specifications will govern how the materials are applied, in what sequence, and any other special considerations that are to be adhered to.
  3. 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.
  4. Temperature requirements for optimal paint coating system performance will be strictly adhered to.

B. ASU prefers alternative solutions to dry erase or whiteboard paint applications.

Quality Assurance:

A. Primers and other undercoat paint shall be supplied by the same manufacturer of the finish coats. Shop primed items are to either be certified as receiving the primer necessary for compatibility with the paint system to be used or the items are to have the proper primer applied before the application of other system components.

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

C. 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.

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

Application:

A. Recommended application techniques:
  1. Metal: Spray applied.
  2. Walls: Spray- or rolled-applied.
  3. Floors: Spray- or rolled applied.
  4. Doors and jambs: Spray- or brush-applied.
  5. Millwork/Casework (prominent): Spray applied.

B. Finishes
  1. Avoid the use of flat paint. Refer to the current IBC for finish standards.
  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.

C. Exterior exposed metal fabrications shall have a spray-applied epoxy-polyamide type primer (as described in 05 50 00), finish paint coat(s) shall also be spray applied – Kynar or equal. A color shall be chosen that does not easily fade when exposed to sunlight, and consideration given to the “faded” color.

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

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

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

Quality Assurance:

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

B. Any touch-ups or repainting required for punch lists needs to be indistinguishable. This most often will 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. PDCA standards are available at: http://www.pdca.org/

D. Exterior metal stairs featuring stair treads and landings that are steel fabrications into which concrete is to be poured must receive special treatment by the DP. The interior of the steel items must be treated before the placement of the concrete so that water cannot come into contact with the steel items. The shop-applied primer is not a waterproof coating and will not inhibit rust. Additionally the concrete shall be tooled resulting in a perimeter joint that will receive a bead of sealant. The concrete itself shall be treated with a waterproofing coating.

E. Repair of paint coating system damaged by construction activities, field welding etc.: The contractor is to repair and reapply the full paint coating system to areas that are damaged or altered during construction. The area in question is to be cleaned and repaired/primed so that the damage is not noticeable. Then the required finish application is to be reapplied. All repair activities are to be in accordance with the original systems specifications and manufacturer's instructions. Small areas shall be treated but the finish shall be reapplied to the entire surface in which the small area is located. Small spot finished areas are not acceptable. The contractor will revisit the painted areas during the 12-month walk through. Any areas that exhibit discoloration or non-uniform aging will be repainted without cost to the owner.

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 facade materials, such as stone.

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 Design Professional (DP) shall submit a sample of the graffiti-resistant coating applied to the intended substrate material at the final schematic design submittal.

D. The use of this type of coating is to be carefully reviewed by the DP, Project Manager (PM) and Facilities Management Department. The coating must be approved by both the DP and FM prior to inclusion into the construction documents.

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, facilitate water vapor passage through the assembly, prohibit water penetration, remain watertight, flexible, and colorfast for longer-than-normal paint applications.

Design Standard

A. The Design Professional (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 Portland cement 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:

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

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

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

D. 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 marker boards, and natural cork tack boards. 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 (4) sets of markers shall be included with every 8'-0" of marker board. Two (2) erasers shall be included with every 8'-0" of marker board. Four (4) 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 porcelainized 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 inches. Marker trays shall be aluminum, solid extrusion with a ribbed section, with smoothly curved ends.

D. Dry marker boards shall be:

1. Porcelain boards, a face sheet of 24-gauge enameling grade steel, with a three (3) coat porcelainized 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 tack boards shall have a single layer, ¼-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 shall never be less than 64 sf. and typically should be 80 sf.

10 14 00 - Signage and Wayfinding

This section outlines the **Signage Design Guidelines** that regulate the design and installation of interior and exterior signage at all buildings and properties owned or leased by Arizona State University. This section can be found at the link below:
www.asu.edu/fm/documents/project_guidelines/ASU-Signage-Guidelines.pdf

10 21 13 - Toilet Compartments

Revised 2020

Description:

This section applies to restroom partitions and screens, but also generally applies to the space itself. Restroom toilet partitions and screens must be designed, specified and detailed Heavy Institutional Use. The Design Professional (DP) shall carefully consider design concepts that facilitate easy maintenance, safety, complete accessibility to the handicapped, and extreme durability. Wall and ceiling construction appropriate to support the specified components is an extremely important aspect of designing for these items. Solid white partitions are not to be specified in ASU facilities.

Design Standard:

A. Doors, Panels and Pilasters shall be constructed of two sheets of type 304, hembossed stainless steel (No exceptions) with laminated under pressure to a “vertical” honeycomb core for impact resistance, rigidity and sound deadening. Formed edges to be welded together and interlocked, under tension, with a roll-formed oval crown stainless steel locking bar.

1. Overhead braced pilasters, shall be 25mm (1“) thick with cover sheets not less than 0.8mm (.030”).
2. Unbraced pilasters, shall be 32mm (1.25“) thick with cover sheets not less than 0.8mm (.030”).
3. Panels and screens, shall be 25mm (1“) thick with cover sheets not less than 0.8mm (.030”).
4. Doors, shall be 25mm (1“) thick with cover sheets not less than 0.8mm (.030”).
5. Head rail, shall be 25mm (1”) by 41mm (1.625”) extruded anodized aluminum with anti-grip design. Wall thickness to be 1.5mm (.060”) and shall be securely attached to wall and pilasters with manufacture’s fittings in such a way as to make a strong and rigid installation.
6. Concealed tapping reinforcement, minimum 14 gauge.
7. Core material sound-deadening honey comb; minimum 1 (one) 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).
11. Provide continuous door hinges at all applications.

B. Partitions in all new construction are to be ceiling-mounted and wall-secured.

C. All accessories shall be chromium-plated finish.

D. Handicapped stalls shall conform in all ways to current (American Disabilities Act) ADA requirements.

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

F. Individual screening of urinals in gang arrangement is generally not acceptable. The DP may propose an anchoring system for consideration by the Project Manager (PM) but these are subject to high abuse and vandalism. It is urged that the DP give considerable thought to his design in this area.

G. A single screen adjacent to a LAV arrangement is acceptable.

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

I. 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.

J. Minimum one (1) floor drain per restroom.

K. See DIVISION - 10 28 13 for Toilet Accessories.

10 22 26 - Operable Partitions

Description:

This section applies to operable partitions used to functionally and acoustically demise 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 sq. ft. 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. Foot bolts and stabilizers shall be internal and edge-activated. No protruding foot bolts 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.

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

K. The selection of the design should include the ease-of-replacement of the partition finish surface. National fabricators with local offices are best suited to address these criteria.

L. The unit must have a two-year workmanship warranty and a ten-year material warranty.

M. Provide options for main door locations and marker boards.

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 oversight.

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 degree 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.

D. Corner guards are to be easily removable and reinstalled/replaced using common tools.

10 28 13 - Toilet Accessories

Description

This section includes toilet accessories that are typical to the majority of projects on ASU Campuses, and does not include special or unusual items that may be applicable on specific projects. The Design Professional (DP) will require the Contractor to provide two (2) specific items that are listed below. These are tied to the University Janitorial/Cleaning Contract.

The DP-shall review this accessory list with the proper representative of Facilities Management administration to ensure that the list is current. For other items, 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 be 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. Hand Dryer at each rest room Dyson Airblade V Hand Dryer Gray (“Sprayed Nickell”), or preferred option, Dyson Airblade Wash+Dry Hand Dryer WD0-5 (Tall).

C. Sanitary napkin dispensers: surface mounted, Bobrick B-2706 Series, convertible coin mechanism (free, 25 cents, or token). Equipped with tumbler lock that opens with different key than furnished for door locks.

D. Sanitary napkin/ waste disposal unit: panel surface mounted; stainless steel with bottom dump. One per toilet compartment, both male and female. In accessible stalls, the disposal unit shall be located below the grab bar (at least 1-1/2”) with the opening of the disposal unit 19 inches minimum (483 mm) above the finish floor. The disposal unit shall not project off the wall surface greater than 4”.

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

F. Wall Hung Toilet Carriers shall be “Heavy Duty” rated for minimum 750-1000 lbs.

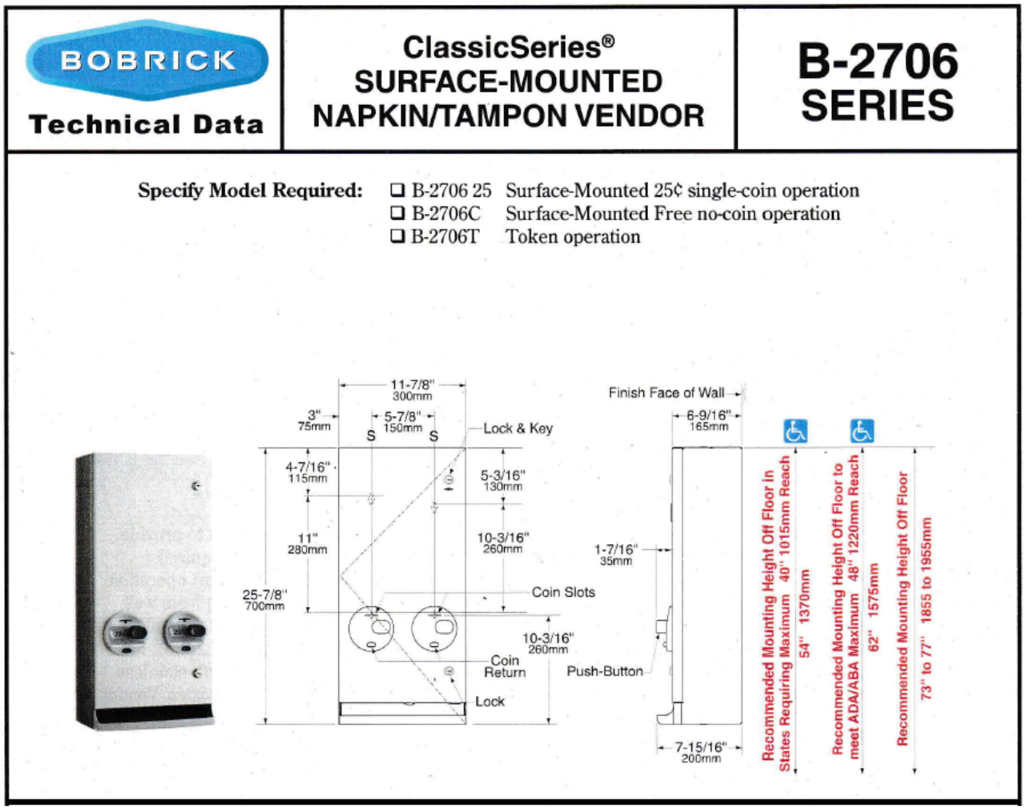
G. Grab bars: at handicapped compartments; 1-1/2 inch diameter, knurled stainless steel finish.

H. Mirrors:

  1. One mirror per lavatory, wall mounted, 18 inch x 36 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. Specific items to be provided as specified: (These items may be purchased from the ASU Cleaning Service Provider directly).

  1. Toilet Paper Dispenser: SCA 56T1 Twin Jumbo JRT BLK - Brady Item Code: PJ0056.
  2. Soap Dispenser: Dial Complete Foaming Soap Dispenser – Smoke or TC Manual Foam Dispenser – Blk.



BOBRICK
Technical Data

ClassicSeries®
SURFACE-MOUNTED
NAPKIN/TAMPON VENDOR

B-2706
SERIES

Specify Model Required:
☐ B-2706 25 Surface-Mounted 25¢ single-coin operation
☐ B-2706C Surface-Mounted Free no-coin operation
☐ B-2706T Token operation

10 41 00 – Emergency Access Classroom Key Box

Description

The classroom safety override system box will be placed in all classrooms that exceed 100 seats. New buildings will be equipped with electronic solution. Remodel of existing space will include the override system and either an upgrade to hardware or the electronic solution.

Design Standard

A. Location: Place near each entry/exit. It is likely that two (2) or more devices will be needed in each space.

B. Remodel of existing space will retrofit all hardware that does not have a locking device.

C. Remodel of existing space with rooms controlled with an electronic card solution (card reader) will have key devices installed near each entry/exit door that will override card access.

10 43 13 – Automatic External Defibrillator (AED)

Description

These guidelines will serve as the procedure for when an Automated External Defibrillator will be required to be installed. These guidelines will also serve as the standard, when installing the AED cabinet, to be in compliance with current regulation. An AED, is an Automated External Defibrillator. This is a life safety device, which is used when someone is in cardiac arrest. ASU is striving to install an AED in every University owned or operated building and facility.

Arizona Revised Statute *§34-401* states:
“Any state building that is constructed or any state building that undergoes a major renovation at a cost of at least two hundred fifty thousand dollars after the effective date of this section must be equipped with automated external defibrillators.”

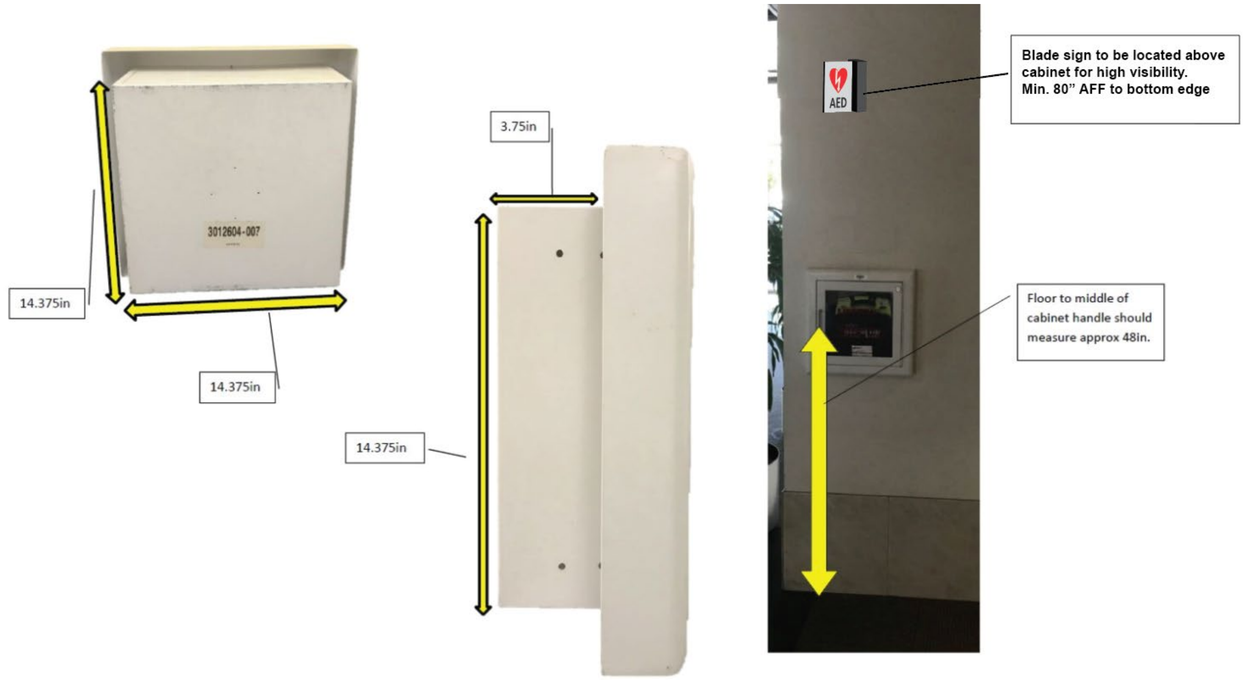
Design Standard

The University Fire Marshal’s Office will coordinate with project management to procure AED’s and AED cabinets from select vendors. If it is a new building then contractors on-site should install the AED cabinet during initial construction. If it is an existing building then ASU Facilities Management can be utilized to install AED cabinet. University Fire Marshal’s office personnel will manage the acquisition, maintenance, and training for all ASU AEDs.

An AED cabinet should be installed following the below dimensions:

A. A 14.375in by 14.375in square cut should be made.
B. Cut should be made 41 inches above ground level

Signage:
ASU Standard Blade signs are required above AED cabinets for high visibility. Overhead projecting blade signs shall be mounted 80” minimum above the finish floor to the bottom of the sign.



Blade sign to be located above cabinet for high visibility. Min. 80” AFF to bottom edge

Floor to middle of cabinet handle should measure approx 48in.

Figure 10-43-13.01 AED Details

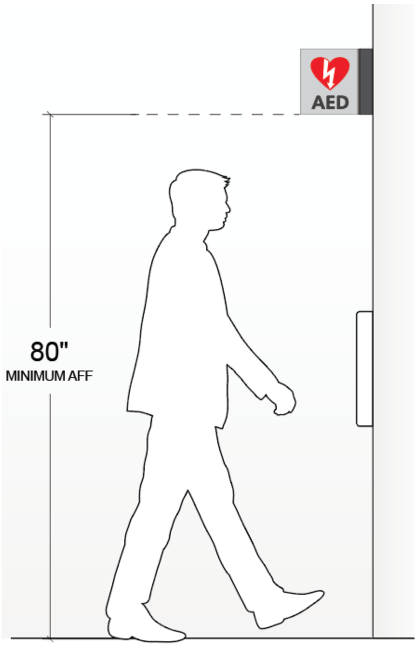


Figure 10-43-13.02 AED Blade Sign Location

10 44 00 - Fire Extinguishers

Design Standard

All portable fire extinguisher installation shall adhere to all currently adopted codes and standards to include, but not limited to International Fire Code (IFC), International Building Code (IBC), and the National Fire Protection Association (NFPA) 10. In addition to the requirements present in this document or required by the ASU Fire Marshal's Office.

All chemical, biological, engineering, and similar laboratories or any other area that may be considered a high hazard occupancy requires a portable fire extinguisher installed in a semi-recessed or recessed cabinet meeting the minimum rating of 4-A:20-B:C. The extinguishing agent shall be ammonium phosphate. Travel distance to a fire extinguisher must not exceed 75 feet.

Areas with flammable metal hazards requires a Class "D" portable fire extinguisher to be installed. The maximum travel distance to an extinguisher in these areas shall not to exceed 50 feet. Carbon dioxide or halon agents are not acceptable.

Mechanical and electrical equipment rooms shall require the installation of a portable fire extinguisher meeting the minimum rating of 20-B:C. The extinguisher may be surface wall mounted, if there is a possibility or exposure to damaging elements or activities, the extinguisher shall be mounted in a surface, semi-recessed, recessed cabinet. If the extinguisher is externally mounted it shall be protected from the elements with a cover/bag designed and approved for this use. The extinguishing agent must be of sodium bicarbonate or potassium bicarbonate base. Carbon dioxide or halon agents are not acceptable. Travel distance to an extinguisher cannot exceed 50 feet. Portable fire extinguishers outside the room/area of protection cannot be included in the travel distance requirements.

Commercial kitchens shall be required to install a Class K portable extinguisher within 30 feet travel distance to the cooking equipment. Installations shall adhere to the requirements set forth, but not limited to in the IFC, NFPA 10, and NFPA 96.

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 the installation of a fire extinguisher with a minimum rating of 4-A:20-B:C. Extinguishing agent must be ammonium phosphate. The extinguisher shall be installed in a semi-recessed or recessed cabinet. Travel distance to a fire extinguisher shall not exceed 75 feet. Cabinets and Extinguishers mounted in Corridors shall be clearly identifiable, as a fire extinguisher shall NOT be covered or decorated to blend in to a decorated wall or other aesthetics to hide the appearance of a fire extinguisher.

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

A. The cylinder head and internal parts shall 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.

Signage:
ASU Standard Blade signs are required above fire extinguisher cabinets for high visibility. Overhead projecting blade signs shall be mounted 80” minimum above the finish floor to the bottom of the sign.

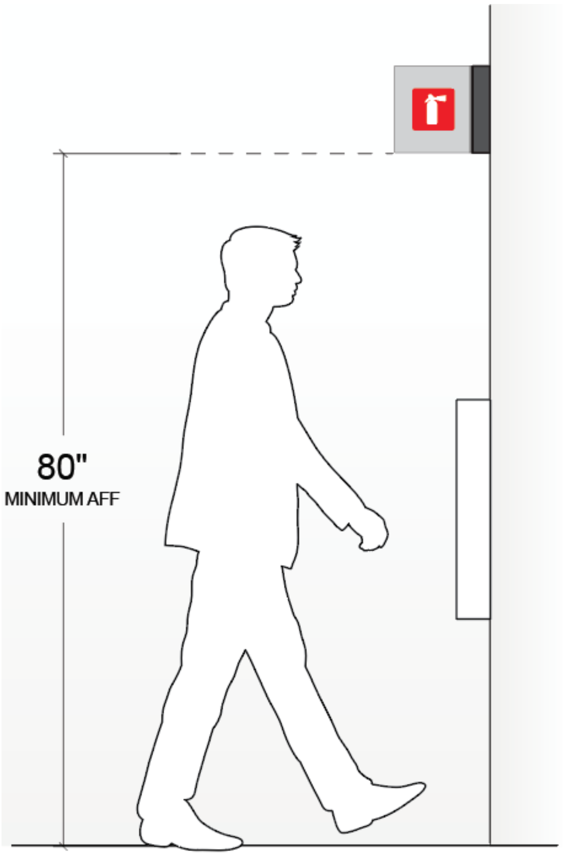


Figure 10-44-00.01 Fire Extinguisher Blade Sign Location

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. Contractor and Design team shall provide a Pest Control Plan for approval by DM, illustrating how the design will prevent birds and other animals from damaging, roosting, or providing a hard to maintain building environment.

Design Standard

A. The use of mechanical, electrical, physical, and chemical repellent systems, and protective devices specifically designed for bird and animal control shall not be allowed unless approved by the Capital Programs Management Group. It is preferred that the building design 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. Mechanical seals are preferred as opposed to caulk based systems.

10 85 00 – Knox Box

Description

Knox Box: Flush mount, 1/4 inch thick plate steel housing, 5/8 inch thick steel door with interior gasket seal and stainless steel hinge, and tamper-resistant fasteners; finish to be selected by Architect. Coordinate order placement with Fire Department authorization. Coordinate mounting height and location in field with Architect.

Product: Knox Company; Knox Box, Series 4400.

Design Standard

A. The Knox box must be facing toward the main fire access to the building and not be obstructed, must be at least 36” off the ground to the key lock and be less than 30” from the front of the structure. The Knox must meet ADA requirements.

DIVISION 11 - EQUIPMENT

11 24 23 - Fall Protection and Window Washing Equipment

Description

To ensure available fall protection for building service and maintenance, fall protection shall be reviewed and designed into the building design per applicable Federal, State, and Local regulations and ASU Policy EHS 120: Fall Protection.

This section applies to exterior window washing support systems that will be required when a building is over (3) stories or 30' in height from average natural grade.

Design Standard

A. The Design Professional (DP) shall, in the schematic design phase, work closely with a company or firm that specializes in the manufacture and supply of the system. The system shall be an integral element in the design and not left as an oversight.

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 manufacturer’s recommendation.

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

H. In all roof areas where the system will need to operate, a minimum 6' walkway shall be provided to gain access to the building façade and all components of the system. This walkway may consist of a built-up cementitious surface, raised industrial type walkway, or built-up pad, but it cannot compromise normal roof drainage or undermine the integrity of the roof in any way.

11 53 13 – Fume Hoods and Other Air Containment Units

Description

A. This section applies to Fume Hoods and Other Air Containment Units in spaces designated for use in laboratories. The design of these units must be designed in conjunction with the lab exhaust systems as complete operating units considering chemical use factors, room supply air, room configuration, hood type and location, exhaust fan, and ductwork.

B. Regulations, Standards and References: For fume hood and exhaust regulations, standards and references, refer to: https://www.asu.edu/ehs/design-guidelines/laboratory-ventilation.pdf

C. Fume hoods work by extracting air and noxious fumes away from the user and out of the fume hood where the air is exhausted to the outside environment by means of a duct system. User protection is enhanced by a movable sash that can be raised or lowered based on the needs of the user.

D. Secondary functions of these devices may include explosion protection, spill containment, and other functions necessary to the work being done within the device.

E. The products available are the constant air volume (CV), the reduced air volume (RAV) and the variable air volume (VAV) fume hoods.

1. Constant Air Volume (CV)

   a. CV fume hoods exhaust the same amount of air, all of the time, and provide a stable and constant air flow with no need for re-balancing. The most common types contain a bypass opening which allows the air flowing through the hood to remain constant (wherever the sash is placed). Bypass openings are also used to combat the air velocity issues that can occur with conventional fume hoods. Also, because the fume hood has a constant operating procedure, the energy consumption remains constant. Non-bypass fume hoods do not contain this opening so the sash can only be closed to a certain degree. This can cause the air velocity to increase to such amounts that it can disturb your equipment and materials.

2. Reduced Air Volume (RAV)
   a. New developments in fume hood technology has allowed new features such as sash stops, horizontal sliding sashes, airflow sensors and small fans to be implemented into the design. This advancement has produced the RAV and VAV ranges which have been found to significantly reduce energy consumption.
   b. RAV's have all the basic principles that CV's do but the bypass opening is partially blocked off causing a reduction in airflow which lowers their energy consumption. The downside of this reduction in airflow is that there's the potential that some of the noxious fumes could escape the fume hood so they can only be used with less noxious compounds.
3. Variable Air Volume (VAV)
   a. VAV's are essentially a more advanced version of CV's and are becoming the fume hood of choice due to their airflow versatility. In VAV fume hoods, the air flow is kept constant but the velocity can be changed to meet the user's requirements. VAV fume hoods regulate the air flow based on the sash height to maintain a given velocity at any sash height. This gives the user control of the amount of air they want exhausted from their fume hood without worrying about any drop in air velocity. They have also been designed to be very user friendly and all parts that need to be changed periodically are easily accessible.

F. Fume Hood Design Criteria:

1. Fume hoods shall be set back against the walls in locations that are out of the normal daily user circulation and are fitted with infills above, to cover up the exhaust ductwork and the potential for dust collection.
2. The front has a sash window, usually in glass, able to move up and down on a counterbalance mechanism.
3. Because of their recessed shape, fume hoods are generally poorly illuminated by general room lighting, therefore internal lights with vapor-proof covers shall be included.
4. Fume hoods should not be situated directly opposite assigned occupied work stations. Materials splattered or forced out of a hood could injure anyone seated across from it. If this condition can not be avoided, then the fume hoods shall be located a minimum of 8'-0" from the opposing work station.
5. Fume hoods also should be so located within the laboratory to avoid cross currents at the fume hood face due to heating, cooling, or ventilation supply or exhaust diffusers. Cross currents outside a hood can nullify or divert air flow onto a hood, negatively affecting its capture ability.
6. Fume hoods shall also be placed away from doors and not located where they would face each other across a narrow aisle. Air velocity caused by supply vents should not exceed 25 feet per minute at the face of the hood. Supply diffusers shall be located far enough away from the fume hood to avoid draft disturbances at the face of the fume hoods.
7. At ASU the preference is to use high performance low flow VAV fume hoods that allow for lower face velocities.

8. Sufficient makeup air must be available within the laboratory to permit fume hoods to operate at their specified face velocities. A fume hood exhausts a substantial amount of air. Therefore, additional makeup air must be brought into the room to maintain a proper air balance.

9. Fume hoods shall not be the sole means of room air exhaust. General room exhaust diffusers shall be provided to maintain minimum air change rates, maintain room pressurization, and temperature control.
10. All Fume hoods shall include air face monitoring. For air face monitoring requirements, refer to: https://www.asu.edu/ehs/design-guidelines/laboratory-ventilation.pdf

11. For additional fume hood placement requirements, refer to the diagrams located at the end of this section.

G. Types of Fume Hoods

1. General Purpose, Bench Top Chemical Fume Hood

    a. A Bench Top Chemical fume hood is a cabinet with a moveable front sash (window) made out of safety glass set on a work surface approximately 36" above the floor which provides a convenient work area for the standing position. The device is enclosed except for necessary exhaust purposes on three sides and top and bottom, designed to draw air inward by means of mechanical ventilation, operated with insertion of only the hands and arms of the user, and used to control exposure to hazardous substances. Air is drawn into the hood under and through the opened sash and is exhausted through openings in the rear and top of the cabinet to a remote point such as an exhaust stack on the roof of the building.

2. Radioisotope Fume Hood

    a. Radioisotope fume hoods are constructed specifically to protect users from radioactive materials. They have specially constructed worktops to withstand the weight of lead shielding plates, and may also have lead laced sashes. Interiors are made of stainless steel with coved corners to aid in decontamination.

3. Distillation Fume Hood

    a. A distillation hood is characterized by a low worktop height which results in a large working height for the operator. This allows tall distillation equipment to be installed and mounted in the work chamber. Otherwise, it has similar features to that of a standard fume hood.

4. Perchloric Acid Fume Hood

    a. Perchloric Acid hoods are required when acid is heated above ambient temperature. Perchloric acid reacts violently with organic materials. Dried perchloric acid is also highly explosive. Therefore, perchloric fume hoods require built-in water wash down systems in order to prevent perchlorate salt deposits. Interior liners are made of acid resistant materials like stainless steel. Interior corners are coved to aid in cleaning. All procedures that use perchloric acid must be confined to a perchloric fume hood, to prevent dangerous reactions with other chemicals.

5. Acid Digestion Fume Hood

    a. Acid digestion fume hoods have special liners manufactured of acid resistant materials such as unplasticized PVC. For acid digestion applications involving high service temperatures, other materials such as PVDF may be used. Sashes may be made of polycarbonate to resist hydrofluoric acid etching.

6. Floor Mounted Fume Hood

   a. Floor mounted fume hoods are used for applications which require large apparatus. As the name implies, these hoods are floor mounted without any work surface. This facilitates the transfer of equipment and materials into, and out from the hood. Floor mounted hoods are sometimes referred to, although wrongly, as walk-in fume hoods.

7. Demonstration Fume Hood

   a. A demonstration hood has all 4 sides made of safety glass, and this hood is commonly used in educational institutions to allow students to easily view the teachers' demonstrations inside the fume hood from all angles, enhancing efficiency in teaching laboratories.

8. ADA Fume Hoods

   a. ADA fume hoods are designed in accordance with the guidelines for the Americans with Disabilities Act. These hoods are also used when a sitting position is desired for work at the hood. They provide the same size work area as the corresponding bench hoods.

9. Canopy Hoods

   a. Custom fabricated stainless steel canopy hoods are used over work areas or equipment to capture heat, odors or steam. Refer to Section 12 35 53: Laboratory Casework and Benchtops.

10. Ductless Fume Hood **(These hoods are NOT allowed at Arizona State University.)**

    a. Ductless fume hoods utilize activated carbon filtration to adsorb chemical vapors and fumes. These hoods recirculate air to the laboratory, and are growing in popularity because of energy savings and the green movement.

11. Not Fume Hoods

    a. Biological safety cabinets, laminar flow clean benches, downdraft tables, fume extractors, pharmacy isolators and snorkels are sometimes mistaken for fume hoods. **They shall not be used for work involving chemicals or solvents. Consult with ASU's Chemical Hygiene Officer for guidance**

12. Snorkels

    a. Snorkels shall only be used to dissipate heat, remove small particulates on the bench surfaces or to dissipate smells and odors in a laboratory.

    b. Due to its poor capture ability, snorkels shall not be used to exhaust hazardous materials

    c. The average capture velocity for snorkels taken at the face of access ports shall be 100- 150 feet per minute (fpm); recommended air flow for these connections is 100 cubic feet per minute (cfm), unless otherwise specified by the manufacturer. (add laboratory design guidelines link.)

13. Gloveboxes

a. For exceptionally hazardous materials, an enclosed glovebox shall be used, which completely isolates the operator from all direct physical contact with the work material and tools. (add laboratory design guidelines link.)

H. Sash Arrangements

1. Vertical Sash

   a. Vertical sash hoods provide the best horizontal and vertical access to the hood interior but they also have the highest exhaust requirements. The exhaust requirements can be reduced by using gravity sash stops, although, this restricts the vertical access into the work area. Split sash hoods can be used where needed for two work areas.

2. Horizontal Sash

   a. Horizontal sash hoods provide good access into the hood vertically and allow for lower exhaust requirements. These sashes do restrict the access across the hood for loading of equipment and apparatus. This limitation becomes less significant in larger hoods.

3. Combination Vertical Rising / Horizontal Sash

   a. Combination vertical rising / horizontal sash hoods, as the name implies, provide the benefits of both the vertical and horizontal sash hoods. For normal operation the sash can be partially raised vertically, or the horizontal panels can be used. The sash can be fully opened vertically for loading equipment into the hood.

Design Standard

A. Bench Mounted Chemical Fume Hoods:

1. Manufacturers: Subject to compliance with project requirements, provide products by one of the following:

   a. Labconco Corporation

   b. Kewaunee Scientific Corporation

   c. Mott Manufacturing Limited

   d. Air Master Systems Corporation

   e. Equivalent, as Approved by OUA and CPMG

2. Materials

   a. Sheet Steel:

      1. Metallic Furniture Stock: ASTM A-1008 mild steel, cold rolled, pickled, double annealed, minimum thickness 18 gauge and free from rust, scales, scratches, buckles, ragged edges, and other defects.

   b. Stainless Steel:

      1. Type 304: ASTM A240; for vertical exposed surfaces, minimum thickness 18 gauge, ground and polished to a Number 4 finish.

      2. Type 316: ASTM A240; for horizontal exposed surfaces, minimum thickness 16 gauge, ground and polished to a Number 4 finish.

3. Welding: All stainless steel welding material shall be of type similar to sheet material. Welds shall be ground, polished, and a subsequent passivation process utilized to blend harmoniously with a Number 4 satin finish without discoloration.

c. Liner and Baffle:

   1. Typical: Glass-reinforced polyester panel, flame-retardant and self- extinguishing with smooth finish and white color. Flexural strength: 14,000 psi. Flame spread index of 0-25 when tested per UL 723 and ASTM E 84. Baffle shall be same material as liner. Liner thickness: 3/16 inch (4.76 mm); baffle thickness: ¼ inch (6.35 mm), minimum.

   2. For Hydrofluoric Acid Hoods: White polypropylene skin bonded to a ¼ inch thick rigid, chemical resistant base.

d. Epoxy Resin

   1. As specified in Section 12 35 53 Laboratory Casework and Benchtops.

e. Glass:

   1. 7/32 inch clear laminated safety glass

f. Sash:

   1. Sash guides: Extruded PVC.

   2. Sash chain: ANSI #35 steel, single strand. Average tensile strength of 2,400 pounds; maximum working load of 480 pounds.

      a. Pulley assembly for sash chain: Finish bored steel drive sprockets and keyed drive, 1/2-inch (12.7 mm) diameter front connector shaft. Rear idler sprockets; double sealed ball bearings type, lubricated. All sprockets steel with zinc dichromate finish.

   3. Sash belt: Two 1/2 inch wide stainless steel-reinforced polyurethane notched belts. Minimum tension cord strength of 840 N.

      a. Pulley assembly for sash belt: Cast aluminum sprocket mated to a steel shaft.

   4. Sash pull shall be one of the following materials, and full width of sash:

      a. Steel with chemical resistant powder coating.

      b. Type 304 stainless steel.

g. Gaskets: Provide PVC gasket at interior access panels to eliminate air leakage and retain liquids inside hood.

h. Fasteners:

   1. Exterior structural member attachments: Sheet metal screws, zinc plated.

   2. Interior fastening devices shall be concealed; exposed screws are not acceptable. Screw head caps are not acceptable.

    3. Exposed exterior fastening devices shall be corrosion-resistant, non- metallic material; exposed screws are not acceptable.

3. Construction:

    a. Design: Fume hoods shall be designed for consistent and safe air flow through the hood face opening. Variations of face velocity shall not exceed ±20% of the average face velocity at any designated measuring point. For face velocity requirements, refer to: https://www.asu.edu/ehs/design-guidelines/laboratory-ventilation.pdf

    b. Superstructure: Rigid, self-supporting assembly of double wall construction. Wall shall consist of a sheet steel outer shell and a corrosion resistant inner liner, and shall house and conceal steel framing members, attaching brackets and remote operating service fixture mechanisms and services. Panels shall be attached to a full frame construction, minimum 14 gauge (2.0 mm) galvanized members. Panels and brackets attached to eliminate screw heads and metallic bracketry from hood interior.

    c. Air Foil: At the bottom of the hood opening and extending across the hood front shall be an aerodynamically designed stainless steel type 316 airfoil. The airfoil shall be mounted with an open space between the airfoil and the bottom front edge of the hood and shall direct air across the work surface of the hood.

    d. Access Panel: Access to fixture valves and piping concealed in wall shall be through flush access panels on the inside liner walls, or through removable front panels. Panels shall be secured with PVC extruded gasket, or tamperproof, epoxy- coated, countersunk flat head screws providing a tight fit. Hook and loop type attachments and panels held by gravity are not acceptable.

    e. Exterior Bypass: 18 gauge (1.2 mm) steel low resistance type. Bypass air shall enter at an opening at the top front superstructure or through upward directional louvers in the upper front exterior panel.

    f. Interior Bypass: Designed to limit variations to the face velocity regardless of sash position. Bypass shall be sufficiently sized for the fume hood configuration and type.

        1. Restricted Bypass: Provide a restricted bypass on all variable air volume (VAV) or constant air volume (CV) fume hoods with combination sashes and on all variable air volume fume hoods with a vertical rising sash.

        2. Non-Restricted Bypass: Provide a non-restricted bypass on all constant air volume hoods with a vertical rising sash.

    g. Baffles: Provide fixed baffles in the rear of the fume hoods interior chamber to control airflow distribution within the hood and through the face opening. Fabricate of the same material as the liner. All baffle supports/brackets to be nonmetallic.

    h. Ceiling Closure Panels: Used to enclose space between top of fume hood and ceiling. Minimum 18 gauge (1.2 mm) thick sheet steel, finished to match fume hood. Provide with a removable front panel for access to hood lights, piping and exhaust duct connections.

    i. Trim and Side Panels: Provide matching steel trim and side panels, as required, to finish any openings around and between hoods. Panels shall be flush with other hood panels, and finish shall match superstructure exterior.

j. Sill: Flush bypass type designed to prevent reverse air flow at the fume hood work surface. Sill to include an integral spill trough with hinged panels for access to trough and that allows pass thru of hospital grade electrical plugs. Mount sill assembly flush with bottom of fume hood work surface. Provide a chemical resistant sealant between sill and work surface.

k. Sash: Full view type with clear, unobstructed, side to side view of fume hood interior and service fixture connections.

l. Finished Back: Provide for any fume hood where back of hood is exposed to view. 18 gauge steel sheet. Finish shall match superstructure exterior.

m. Bypass Grille: Low-resistant type 18 gauge steel with upward directional louvers.

n. Exhaust Duct Collar: Provide Type 316L stainless steel, minimum 18-gauge, duct collar with 1 ½ inch (38 mm) to 2 inch (50 mm) extension above top of fume hood with butt joint termination suitable for welding. Duct collar design shall be bell-mouthed for round or contoured design for rectangular to provide lower static pressure drop and improved noise performance. Duct collar shall be integral to fume hood construction, factory-installed, and welded or permanently sealed airtight to hood.

o. Exhaust Duct Transition Piece: Furnished by the fume hood manufacturer for installation by the mechanical contractor. Provide contoured Type 316L stainless steel, minimum 18 gauge, exhaust duct transition piece to connect to the fume hood exhaust duct collar and Laboratory exhaust duct system. Provide butt joint terminations suitable for welding.

p. Cup Sink: (to be installed **only** in special situations. (**Normal design is not to install cup sinks inside fume hoods.)**

    1. Oval with raised rim, material and color to match work surface, sizes in accordance with drawings.

    2. For floor-mounted hoods, wall-mounted oval molded black epoxy resin complete with strainer, outlet and wall mounting bracket.

    3. Raised Rim Height: ¼ inch (6.35 mm).

q. Piping shall be per ASU Guidelines.

r. Service Fittings: Factory-installed and complete with all gaskets, grommets and sleeves. No additional holes in fume hood side posts shall be provided for services beyond those required for the project.

s. Control Valves: Control valves shall be mounted on the front panel of the fume hood, with all components subject to wear accessible from the exterior of the hood.

t. Alarm: Provide a local audible and visual alarm device capable of detecting a drop or rise in airflow (not static pressure) through the hood such that, if the hood exhaust volume falls below or rises above a preset exhaust level, the alarm will sound and the alarm light will come on. Local Audible and visual alarm must have capabilities for remote monitoring hook up.

    1. All cut outs for alarm shall be made in the factory; field cutting is not acceptable.

    2. Locate at 48 inches or below for all Accessible designated fume hoods.

u. Electrical:

    1. Pre-Wiring: All fume hood electrical devices shall be factory-installed and wired to a junction box located on top of the hood.

v. Interior Hood Lighting

    1. Type of lighting:

        a. Lighting within the hood shall be provided by a UL approved, vapor-proof, LED light fixture operated by an exterior switch with a stainless steel cover plate. LED light color shall be 3,000K to 3,500K. Light fixture shall be approved for recessed and enclosed spaces, and third-party tested to 50,000 hours.

    2. Light level: Average light level on the work surface shall be 80 foot- candles, minimum.

w. Labeling: Fume hoods shall be labeled to indicate intended use (i.e. “Perchloric Acid Hood”, Radiation Use Hood”, etc.).

    1. A label shall be affixed to each device containing the minimum following information from the current performance test and inspection:

        a. performance test date

        b. average face velocity

        c. inspector's initials

x. Operation Instructions: Provide a permanent chemical resistant decal or plate attached to fume hood exterior with condensed information covering the following:

    1. Recommended locations for apparatus and accessories.

    2. Recommended safe operating procedures.

    3. Use of sash.

    4. Baffle settings.

x. Hood Finish: As specified elsewhere in this Section.

y. Exterior Color: As selected by Architect from manufacturer's full color line and complying with finish requirements.

z. Work Surface: 1-1/4 inch thick epoxy resin. Refer to Section 12 35 53 for requirements.

aa. A performance test must be performed and a ventilation profile sticker with sash height settings must be installed for proper working sash height.

bb. An ASU Green Labs safety/sustainability performance sticker shall be affixed to each fume hood. The sticker is available from ASU EHS.

B. Floor-Mounted (Walk-In) Chemical Fume Hoods:

    1. Subject to compliance with the project requirements, acceptable models include:

    a. Protector XL Floor-Mounted Laboratory Hood by Labconco Corporation.
    b. Supreme Air Walk-In Fume Hood by Kewaunee Scientific Corporation.
    c. Pro Series Floor-Mounted Fume Hood by Mott Manufacturing Limited.
    d. Eliminator 400 Series Fume Hoods by Air Master Systems Corporation.
    e. Equivalent, as Approved by OUA and CPMG

C. Perchloric Acid Hoods:

  1. Subject to compliance with the project requirements, acceptable models include:

    a. Protector PVC Perchloric Acid Fume Hood by Labconco Corporation.
    b. Supreme Air Perchloric Acid Fume Hood by Kewaunee Scientific Corporation.
    c. Eliminator 700 Series Fume Hoods by Air Master Systems Corporation.
    d. Equivalent, as Approved by OUA and CPMG.

D. ADA Accessible Hoods

  1. Handicapped accessible hoods shall be as described above, but designed to meet all handicapped accessible standards.

  2. Light switches, electrical receptacles, and service fixtures shall be mounted no higher than 48” above finished floor.

E. Fume Hood Base And Special Cabinets

  1. Under Counter Flammable Liquids Storage Cabinet

    a. Acceptable Manufacturers:

      1. Justrite Manufacturing Company, L.L.C.
      2. Equivalent, as Approved by OUA and CPMG.

    b. Cabinets shall be Factory Mutual (FM) approved or Underwriters Laboratories (UL) listed.

    c. Ventilation: Refer to EHS Guideline “Hazardous Material Storage” at: https://www.asu.edu/ehs/design-guidelines/hazardous-material-storage.pdf

    d. Casing: Bottom, top, back, door and sides of cabinet shall be at least 18 gauge sheet steel, double-walled with 1-1/2 inch air space. Joints shall be welded airtight. Provide with adjustable zinc-plated leveling legs.

    e. Door: Provide with continuous piano hinge and a 3-point latching arrangement with door sill raised at least 2 inches (50 mm) above the bottom of the cabinet to retain spilled liquid within the cabinet. When more than 1 door is used, there shall be a rabbetted overlap of not less than 1 inch (25 mm). Provide self-closing, self-latching door(s) with fusible link(s) to hold doors wide open and melt at 165 degrees Fahrenheit (73.8 Celsius) for automatic closure.

f. Ground (to structure) and bond cabinet.

g. Provide flame arrestor on cabinet vent outlet.

h. Provide an adjustable, full width, metal shelf supported with “locking” clips to avoid inadvertent removal.

i. Apply silkscreen signage, color red, in a conspicuous size to cabinet doors indicating “FLAMMABLE – KEEP FIRE AWAY”.

j. Color: Manufacturer’s standard yellow.

2. Under Counter Corrosive Storage Cabinet

   a. Acceptable Manufacturers:

      1. Justrite Manufacturing Company, L.L.C.

      2. Equivalent, as Approved by OUA and CPMG.

   b. Ventilation: Refer to EHS Guideline “Hazardous Material Storage” at: https://www.asu.edu/ehs/design-guidelines/hazardous-material-storage.pdf

   c. Doors: Provide with louvered vents near bottom of each door and polypropylene or ABS roller catches with stainless steel screws.

   d. Casing: Bottom, top, back, door and sides of cabinet shall be at least 18 gauge sheet steel, double-walled with 1-1/2 inch air space. Joints shall be welded airtight. Provide with adjustable zinc-plated leveling legs.

   e. Liner: Provide cabinet with chemical resistant thermoplastic coating on all interior surfaces, similar to ChemCor coating as manufactured by Justrite.

   f. Bottom: Provide with 1/4 inch (6mm) thick heat welded, polypropylene or ABS plastic pan, liquid tight removable, 1 inch (25mm) deep.

   g. Shelving: Provide with a half depth, adjustable shelf for the full width of the cabinet with polypropylene shelf clips.

   h. Identification: All under-counter ventilated cabinets shall be marked with conspicuous lettering: “CAUTION- CORROSIVES”.

   i. Color: Manufacturer’s standard dark blue.

3. Under Fume Hood Flammable Storage Cabinets and Corrosives Cabinets

   a. Description: Where a Flammable Storage Cabinet and a Corrosives Cabinet are both located below a fume hood, the following shall be provided:

      1. Corrosives Cabinet shall vent directly into and through the fume hood.

      2. Flammable Storage Cabinet shall vent separately from the fume hood and shall have connections both high and low to the back of the Flammable Storage cabinet to be

combined into one exhaust duct that will run independent up through a void space in the fume hood extending vertically to above the ceiling and then run horizontally above the ceiling to a point where there would not be any fire/life safety issues in the exhaust system as determined by the mechanical engineer.

4. Vacuum Pump Cabinet

   b. Description: Where noted on drawings, provide the following modifications to the standard cabinet: provide (1) 2 inch diameter hole in the back of the cabinet and one in the work surface behind it for access of owner furnished vacuum hose. Provide raised lip at countertop hole to prevent spills from flowing into or behind cabinet.

   c. Ventilation: Provide (2) 2 inch diameter exhaust collars at top and bottom of cupboard rear for vent connection.

   d. To support cabinet ventilation, provide a small fan mounted at the back of the cabinet to exhaust air out of the cabinet.

   e. Electrical Requirements: Provide a 110V, 20amp duplex, NEMA 5-20R receptacle in the back panel of the cabinet controlled by a switch with a pilot light and stainless steel face plate on the face of the cabinet for the pump's power cord and fan.

   f. Bottom: Provide a pull-out tray on full-extension glides capable of supporting a 150-lb pump. Top of tray shall be fabricated of 304 stainless steel with a 1 inch high watertight lip around the perimeter.

   g. Interior: Interior surfaces of the cabinet to be covered by 1 inch thick closed cell neoprene. Door to cabinet to have a 1 inch open space between the door and dolly to allow air to flow though cabinet.

   h. Exterior finish to match fume hoods.

F. Lattice Rod Assembly

1. Lattice Rod Assembly: Where indicated on drawings, provide a lattice rod assembly mounted to work surface and side walls and held 4" off back wall/baffle. Frame shall support horizontal and vertical rods of ½ inch diameter stainless steel spaced 12 inches on center. Use lattice clamps at each rod intersection. Rods can be individually removed. Laboratory casework contractor shall provide blocking and mounting requirements. Lattice rod assembly shall be as wide as the fume hood and nominally 4'-0" high. Maximize coverage horizontally and vertically.

<u>Certification Requirements</u>

A. Certification shall be provided for following:

1. Newly installed fume hoods

2. Recommissioned fume hoods (i.e. hoods placed back into service after previously decommissioned)

3. Fume hoods affected by alterations to exhaust system. Such alterations may include:

   a) Duct modifications

   b) Exhaust fan modifications

c) Addition or removal of hoods to/from system

d) Laboratory control system modifications

A. Certification shall be based upon hood type and sash position as follows:

1. Standard performance fume hoods shall be certified with sash at operating position.

2. High performance fume hoods shall be certified with sash at full open position.

Fume Hood Placement Requirements for New Buildings and Renovations:

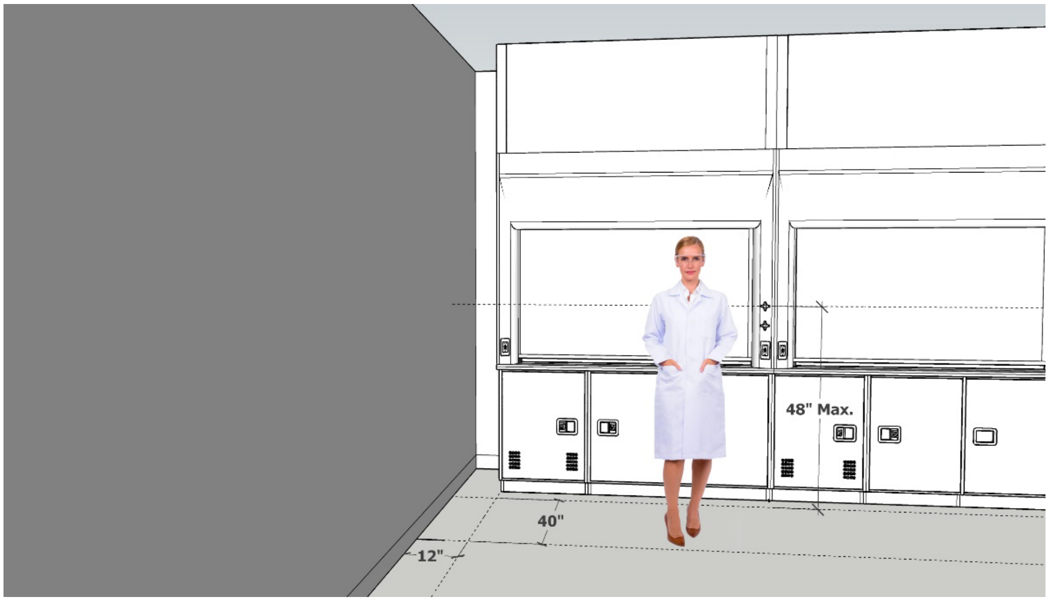


Diagram 1: Fume Hood Edge Distance to Side Wall

- Provide 12 inches minimum from side of fume hood to wall to allow proper air flow to fume hood. This also provides usable space to locate gas cylinders, waste baskets, etc.
- 40 inches are also the recommended working area in front of fume hoods.
- **Note**, to meet ADA Compliance, all fume hood devices such as switches, outlets, etc. shall not be located higher than 48 inches above the finished floor.

Diagram 2: Fume Hood Side Distance to Face of Side Lab Casework

- Provide 40 inches minimum from side of fume hood to face of lab casework to allow proper air flow to fume hood and safe working area in front of the lab casework for the users.

Diagram 3: Fume Hood Distance to Lab Equipment

- Provide 48 inches minimum from fume hood work surface to front of major lab equipment such as refrigerators, freezers, etc. to allow proper air flow to fume hood and provide safe working area for the user.
- Provide 40 inches minimum from the side of a fume hood to edge of a door opening or framed opening to allow proper air flow to fume hood.

Diagram 4: Fume Hood Distance to Lab Casework when Located in an Exit Access

- Provide 100 inches minimum from fume hood work surface to edge of lab casework when located in an exit access to allow proper air flow to fume hood and provide safe working area for the users.

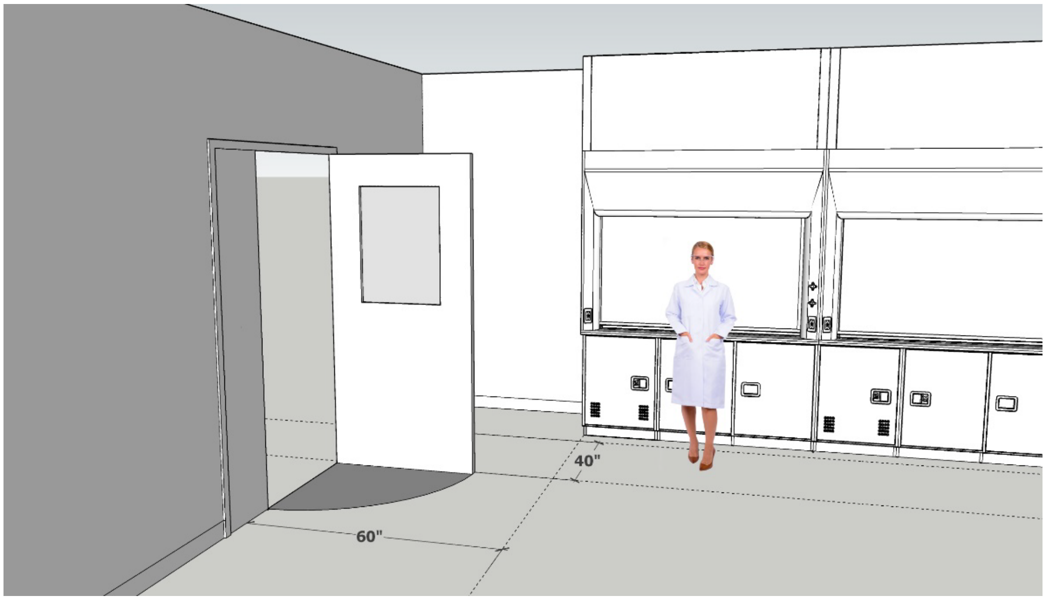


Diagram 5: Fume Hood Distance to Door Opening or Framed Opening Toward the Side of a Fume Hood

- Provide 60 inches minimum from side of fume hood to wall surface when a door opens into a lab or lab support area toward the side of a fume hood to allow proper air flow to fume hood and safe working area for the user.
- Provide 40 inches minimum from the side of fume hood to a framed opening into a lab or lab support room to allow proper air flow to fume hood.

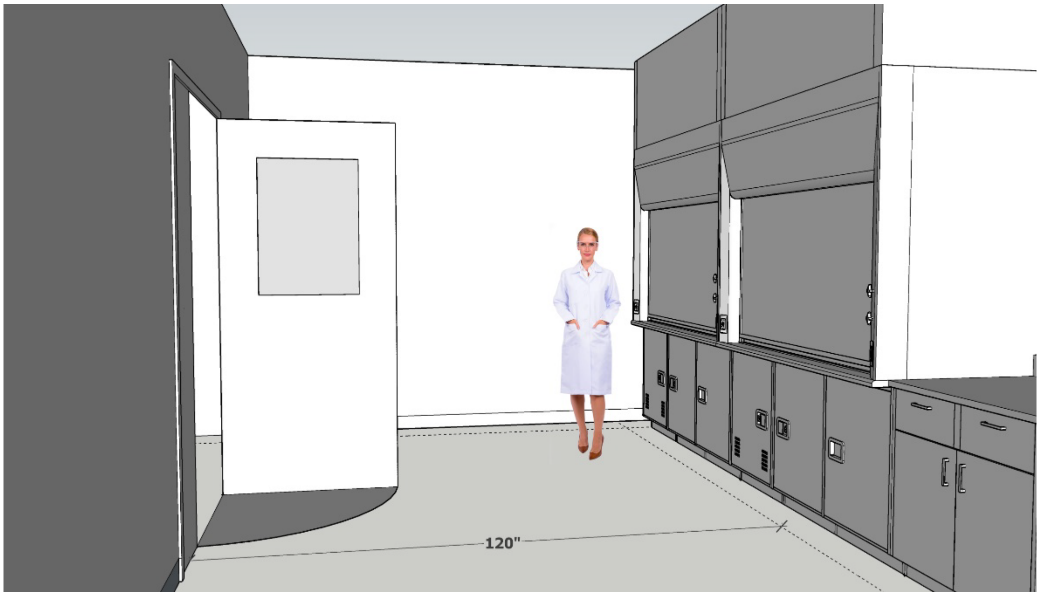


Diagram 6: Fume Hood Distance to Door Opening or Framed Opening in Front of a Fume Hood

- Provide 120 inches minimum from fume hood work surface to face of door when a door opens into a lab or lab support room to allow proper air flow to fume hood(s).
- **Note**, provide 84 inches minimum from fume hood work surface to the front of a framed opening into a lab or lab support room to allow proper air flow to fume hood(s).

Diagram 7: Fume Hood Distance to Open Lab Benches when Located in the Back of a Lab

- Provide 60 inches minimum from fume hood work surface to the edge of open lab benches when the fume hood(s) are located at the back of a lab and not in the main lab circulation aisle to allow proper air flow to fume hood.
- **Note**, in this arrangement, the lab benches located opposite the fume hood(s) shall not be assigned to any users as working bench space, but can only be used by the same individuals using the fume

hoods. These benches could be used for shared equipment which is only attended intermittently.

Diagram 8: Fume Hood Distance to Lab Casework when Located in a Lab or Lab Support Room

- Provide 60 inches minimum from fume hood work surface to the lab casework when the fume hood(s) are located in a lab or lab support room.
- **Note**, in this arrangement, the lab benches located opposite the fume hood(s) shall not be assigned to any users as working bench space, but can only be used by the same individuals using the fume hoods. These benches could be used for shared equipment which is only attended intermittently.

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 the 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 1/4 turn ball valve style or equal.

J. P-Trap: Minimum size to be 1-1/2 inch diameter.

11 61 50 – Controlled Environmental Rooms

Description

A. Controlled environment rooms are used for short and long-term experiments that are temperature controlled (warm or cold), or humidity sensitive and often require instrument set ups that are not easily moved.

B. A cold room is an environmentally controlled prefabricated unit usually operated at 4 degrees C. A warm room is an environmentally controlled prefabricated unit often used for growing cell cultures, usually at 37 degrees C at a constant temperature and humidity. Controlled environment rooms are available with variable temperature ranges and can be adjusted for use either as a cold or warm room.

C. Controlled environment rooms should have stainless steel counters on legs, stainless steel shelves, and a stainless steel sink. Utilities include power, vacuum, and mechanical ventilation, filtered water, and fire alarm strobe light. Requirements for compressed air, gas and vacuum shall be verified during programming. A stainless steel sink is sometimes required. Temperature controlled rooms shall be lockable, and all mechanical components shall be accessible and serviceable. A high and low temperature monitoring and alarm system shall be connected to a central equipment alarm system and set up to provide text alerts. All gaps between the room and adjacent construction shall be properly sealed. Controlled environment rooms shall be connected to the Critical Standby Emergency Power and provide emergency exhaust capability. A manual door release must be provided inside the environmental room.

D. Controlled environmental rooms shall also be designed to provide pass-thru windows if researchers request the need for these pass-thru windows.

E. Controlled environment rooms design and specifications must be developed in conjunction with OUA, EHS and CPMG.

Design Standard

A. Manufacturers

1. Acceptable Manufacturers/Fabricators and Products: Subject to compliance with requirements of Contract Documents as judged by the Architect, provide product by one of manufacturers/fabricators listed. If not listed, submit as substitution according to the Conditions of the Contract and Division 01 Section “Substitution Procedures”.

   a. Environmental Growth Chambers

   b. S P Scientific

   c. BioCold Environmental Inc.

    - d. Harris Environmental Systems
    - e. Equivalent, as Approved by OUA and CPMG

2. Single Source Responsibility: Furnish each type of controlled environment room product from single manufacturer. Provide secondary materials only as recommended by manufacturer of primary materials.

B. Room Construction

1. Rooms shall be of modular construction incorporating wall, roof and floor panels consisting of foamed-in-place polyurethane insulation sandwiched between interior and exterior metal surfaces. Provide panels in standard size increments, fully interchangeable, and in a configuration that meets the specified dimensions. Structural metal, wood, or fiberglass material shall not be used between interior and exterior surfaces.

2. Insulation: Foamed-in-place non-CFC polyurethane with a minimum R-30 for 4 inch(100 mm) thick panels and R-15 for 2 inch(50 mm) thick panels. Foam shall be 97 percent closed cell, impervious to moisture. Insulation shall bond the panel and have a minimum compressive strength of 28 pounds per square inch (193 kPa). Insulated panels shall comply with current EPA Regulations for CFC emission.

3. Assembly: Panel sections shall lock together from inside the room with non-corrosive cam type fasteners, providing accurate, tight joining. Provide a minimum of 3 locking devices on each vertical joint. Distance between locking devices shall not exceed 48 inches (1220 mm). Edge of panels shall be tongue and groove construction with every tongue including an interior and exterior flexible vinyl gasket to ensure a tight fit. Batten strips or pressure clips as a means of covering seams or joining panel sections shall not be utilized. Close wrench holes with flush mounted plastic or stainless steel caps.

4. Panels shall have a flame spread of not more than 25 and a smoke generation of 450 or less when tested in accordance with ASTM E84 and as certified by Underwriters Laboratories.

5. Wall Panels:
    - a. Thickness: 4 inches (100 mm).
    - b. Interior Surfaces:
        1. 0.04 inch (1 mm) smooth aluminum with white polyester enamel finish.
    - c. Exterior Surfaces:
        1. 0.04 inch (1 mm) smooth aluminum with white polyester enamel finish.
    - d. Reinforce wall panels to support wall mounted shelving shown on the Drawings.

6. Roof Panels:
    - a. Thickness: 4 inches (100 mm).
    - b. Interior Surfaces.
        1. 0.04 inch (1 mm) smooth aluminum with white polyester enamel finish.

c. Exterior Surfaces:

  1. 0.04 inch (1 mm) smooth aluminum with white polyester enamel finish.

d. Provide roof platform for easy access to service equipment and reinforce roof panels to support equipment loads without violating the insulation value of the panels.

7. Floor Panels:

a. Thickness:

  1. 2 inches (50 mm)

b. Interior and exterior surfaces:

  1. 14 gage (1.994 mm) galvanized sheet steel capable of handling floor loads up to 600 pounds per square foot (2940 kg per square meter).

c. Ramps: **(Only provide ramps when these units are constructed in existing facilities. For new facilities the floor panels shall be recessed into the floor slab such that no ramps are required).**

  1. Provide a 1 inch rise for each 12 inch run ramps at all doors with height transitions, extending inside or outside of rooms. Note, if providing exterior ramps, they shall be designed to meet ADA requirements for the sides of the ramp as well as the length.

d. Provide with a non-skid surface, color selected by the Owner's Representative from one of the manufacturer's standard colors.

8. Doors:

a. Door shall be in-fitting and flush-mounted, with a minimum clear opening of 36 inches wide by 78 inches (915 mm by 1980 mm) high. Doors shall have a thermal resistance within 10 percent of that for wall panels.

b. Observation Window: Minimum of 18 inches by 12 inches (45 mm by 300 mm), 3 pane hermitically sealed window. Window shall be removable for replacement.

c. Gaskets: Extruded vinyl, resistant to oils and sunlight, and easily replaceable. Provide anti-sweat heaters to control condensation as a standard item on all door jambs at rooms designed for operation below 5 degrees Celsius.

d. Hardware: Polished aluminum, cam action type, self-closing, self-lubricating, and edge or strap mounted with stainless steel. A minimum of 2 hinges per door, adjustable for proper gasket seal.

e. Lock: Provide with keyed cylinder lock capable of release from the room interior whether or not the door is locked.

9. Closure Panels:

a. Furnish and install vertical and horizontal closure panels, strips and shrouds to close opening between environmental rooms and adjacent building partitions and ceiling.

b. Finish to match adjoining environmental room wall panels.

C. Room Interiors

1. Lay in Ceiling, not required in freezers: Provide a 24 inch by 48 inch (610 mm by 1220 mm) eggcrate type lay in ceiling panels supported by anodized aluminum grid members and covering the total ceiling area. Panels shall be acrylic with 1/2 inch square perforations.

2. Ceiling Plenum:

    a. Plenum to contain conditioning modules, heating elements, control valves and other equipment necessary to condition the room air to maintain specified conditions.

    b. Conditioned air shall be directed into a positive pressure plenum extending across the room ceiling. Plenum to provide the correct percentage of total opening to ensure uniform air distribution throughout the room.

3. Flooring:

    a. Acceptable Manufacturers:

        1. Altro,

        2. Armstrong

        3. Mannington

        4. Equivalent, as Approved by OUA and CPMG

    b. Crevice free, non-absorbent, slip resistant, abrasive, vinyl flooring.

    c. Depending on room size, floors shall be seamless or have welded seams, coved 4 inch(100 mm) up sides and capped with vinyl trim piece and continuously silicone sealed between vinyl cap and walls.

    d. Color: Selected by the Owner's Representative from one of the manufacturer's standard colors.

    e. Flooring shall have temperature stability, dimensional stability and flexibility from -20 degrees Celsius to 60 degrees Celsius.

    f. Flooring shall meet the current slip resistance Static Coefficient of Friction Guidelines of the Americans with Disabilities Act and OSHA, and be unaffected by surface water.

    g. Provide flooring with an underlayment as recommended by the flooring manufacturer.

4. Lighting:

    a. Interior room lighting shall be controlled by an external switch with an operational pilot light mounted at 48-inch elevation in the room panel adjacent to the door latch.

    b. Lighting system shall utilize 4 foot-0 inch (1219 mm) 3500 K color temperature LED lamps. Lamps and low temperature drivers to be enclosed in vapor-proof gasketed U.L. Listed fixtures with damp location label rated to operate down to the following temperatures:

1. 0°C: for rooms operating at 4°C and above.
2. -20°C: for rooms operating between 4°C and -20°C.

c. Light fixtures to be mounted above diffusion grating in ceiling plenum in sufficient quantity to maintain an average light intensity of 75 foot-candles at 36 inches (807 lx at 914 mm) above the room floor at design operating temperature. If wall mounted shelving is specified, this light intensity level shall not be required where shading by the shelves causes shadows.

d. Lighting shall be furnished, installed and pre-wired to control cabinet and designed for 120V operating voltage.

e. Switch: Provide with pilot light and locate outside of the room next to the door.

f. If specialized lighting is required, such as UV applications, this lighting option shall be equipped with custom lighting controls for use; and shall be reviewed and approved by EHS prior to installation.

5. Wall Mounted Shelving: (Supplied and installed as part of the Laboratory Casework Package.)

a. Type 316: stainless steel shelving, minimum thickness 16 gauge, ground and polished to a Number 4 finish.

b. Size: Shelf depth of 12 inches (460 mm) unless otherwise shown on the Drawings. Maximum spacing of 24 inches (1220 mm) between wall mounted support posts. Provide two tiers of shelving unless otherwise indicated on the Drawings.

6. Casework, Sinks and Distillation Racks: (Supplied and installed as part of the Laboratory Casework Package.)

D. Refrigeration System

1. Design:

a. Complete integrated system consisting of a conditioning module, compressor / condenser unit, interconnecting piping, interconnecting wiring, and controls designed for continuous system operation. The refrigeration system shall be a fully modulating type which continuously proportions the mixture of liquid and hot gas phases of the refrigerant entering the evaporator, utilizing a modulating control valve. On/off solenoid valve type of control will not be acceptable. The system shall also include high/low pressure controls, receiver, expansion valve, and all necessary components for a complete system to achieve the specified performance.

b. Refrigerant: R-134A or R-404A for rooms 4 degrees Celsius and above, R-404A for freezers.

c. Drain Pans: Provide an insulated, stainless steel or heavy gage aluminum, condensate drain pan large enough to collect all condensate during normal operating and defrost cycles.

2. Compressor/Condenser Unit:

a. Water cooled, semi-hermetic or scroll, serviceable unit sized to maintain temperature / humidity conditions scheduled for each room on the drawings.

b. Unit shall be designed for continuous operation for maximum compressor life and to eliminate on-and-off cycling.

c. The compressor / condenser unit shall be linked to an evaporator of matching capacity.

d. Unit to be located above the enclosure.

e. Water cooled units shall be provided with modulating water regulating valves to maintain head pressure.

3. Automatic Defrost System:

   a. For rooms with set point temperature between 0 degrees Celsius and 6 degrees Celsius, provide hot gas defrost with timer and fan delay switch. Set defrost initiation time and duration so that room temperature increase is minimized while achieving complete removal of accumulated frost. Electric heat trace and insulate drain pipe.

   b. For rooms with set point temperature 0 degrees Celsius and below, provide electric defrost with timer and fan delay switch. Set defrost initiation time and duration so that room temperature increase is minimized while achieving complete removal of accumulated frost. Electric heat trace and insulate drain pipe.

4. Insulation: Suction and hot gas refrigeration lines shall be insulated with a closed cell foam plastic insulation. The material shall be tubular in form and sized according to the pipe size. Joints shall be thoroughly bonded by the adhesive recommended by the manufacturer of the insulation. Insulation shall meet local and state fire and smoke requirements. Penetrations of the insulation must be thoroughly sealed to form a complete vapor barrier. Wherever the insulation terminates, the edges shall be sealed to the pipe with sealant.

   a. Humidity Control System(s):

      1. General: Humidity shall be maintained at a level to avoid condensation on room surfaces under operating conditions. Dehumidification shall be accomplished using the refrigeration system.

E. Ventilation System

1. Environmental rooms 4 degrees Celsius and above, must maintain specified design conditions, as scheduled, with ventilation supply and exhaust provided on a continuous basis from the building HVAC system.

2. Provide a 4 inch diameter exhaust duct collar through the roof of the environmental room for connection to the building laboratory exhaust systems. Insulate entire run of exhaust duct, from the duct collar on the environmental room roof, to the location in the run where the air is properly mixed to prevent condensation.

3. Provide a 4 inch diameter supply duct collar through the roof of the environmental room for connection to the building laboratory supply air system. Termination of the supply air duct in the ceiling plenum shall be at warm side of the evaporator.

4. Do not provide ventilation air to freezer rooms.

F. Controls

1. Locate all instruments and controls in a control panel on the outside of the room, mounted at eye level. Provide panel with a clear acrylic cover and a lock with two keys.

2. Control Panel Service Enclosure: Provide a removable service enclosure panel from control panel to 6 inches above ceiling. Exposed fasteners will not be allowed. Finish to match control panel.

3. All equipment, instruments, controls, lighting, receptacles, and switches, with the exception of the condensing unit power supply, shall be factory pre-wired to control enclosure for a single point power connection. Provide separate over-current protection utilizing circuit breakers for all circuits required for the operation of the equipment and fixtures connected to the control panel.

4. Main Temperature Control: Microprocessor based PID controller designed for environmental room applications with the following features:

    a. Resistance Temperature Detector (RTD) 100 ohm platinum sensor for rapid response to temperature fluctuation, open tip for environmental rooms. Sensitivity shall be greater than or equal to plus or minus 0.1 degree Celsius.

    b. The microprocessor PID controller shall continuously monitor room condition versus set point, providing an output which will modify the conditioning system capacity in response to any deviation.

    c. Controller range shall be established to cover the required range of the room as scheduled.

    d. Accuracy: Plus or minus 0.25 percent of reading plus 1 digit over advertised span at 25 degrees Celsius.

    e. Ambient Temperature Error: 0.01 percent of span per degree Celsius deviation from 25 degrees Celsius.

    f. Resolution: 1 degree/unit.

    g. Calibration Drift: Self compensating for ambient temperature. All calibration values shall be stored in memory. No field calibration shall be required.

    h. Noise Rejection: Normal mode, 85 dB minimum at 60 Hertz or greater. Common mode, 90 dB minimum.

5. High Temperature Safety Control: Provide a separate and independent safety control circuit and devices installed in the control panel. This control shall be a sensitive electronic controller with set point dial calibrated in degrees Celsius. In the event of a high temperature alarm condition, the safety control will de-energize the heaters and lights in the room and activate an audible and visual alarm. A panel mounted momentary contact push button shall be provided to deactivate only the audible portion of the alarm. When temperature returns to the normal range, the heaters, lights, and alarm system shall automatically reset. Provide dry contact for connection to external alarm.

6. Low Temperature Safety Control: Provide a separate and independent safety control circuit and devices installed in the control panel. Its sole function shall be to deactivate the refrigeration system and activate audible and visual alarms in the event of a low temperature alarm condition.

This control shall be a sensitive electronic controller with set point dial calibrated in degrees Celsius. A panel mounted momentary contact push button shall be provided to deactivate only the audible portion of the alarm. When temperature returns to the normal range the alarm system shall automatically reset. Provide dry contact for connection to external alarm.

7. Data logging: System shall include capacity for logging of all closed-loop control channels with ability to transfer or download to portable media. System shall be capable of storing a minimum of two hundred seventy-five (275) days, logged at five-minute intervals, of data locally (at the chamber). All data is stored in unencrypted format for transfer and analysis by user.

G. Personnel Emergency Alarm

1. Provide room with a reset type, electrically powered personnel emergency alarm system. Power shall be from the room electrical input. The system shall consist of an actuator within the room and audible and visual alarms affixed to the front exterior of the room. Provide an additional alarm for the building automation system utilizing two dry contacts.

2. The alarm system actuator shall be a heavy duty, oil tight switch, equipped with a red button marked, "EMERGENCY ALARM - PULL TO RESET." The actuator shall be mounted on the interior wall of the room adjacent to the door jamb and 12 inches (300 mm) above the finish floor.

3. The audible alarm shall be of a type that provides a high decibel level of sound output at a frequency distinct from room parameter alarms. The visual alarm shall be mounted in an area providing no vision interference and shall be prominently labeled "PERSONNEL EMERGENCY."

H. Plumbing:

1. The room manufacturer shall provide all plumbing work inside the controlled environment room. All plumbing work shall be extended outside of the room envelope to connection to building plumbing systems.

2. Work performed under Division 22 shall make final connection from controlled environment room condensate drain connection to sink trap drain, floor sink, or other approved drainage receptor located outside the room.

3. Condensate drain piping shall be Type L, hard drawn copper tubing with wrought copper fittings and soldered joints. Provide heat tracing and insulation to the condensate drain piping for rooms operating at 0°C and below. Condensate piping shall be run within the suspended ceiling plenum to outside of room and routed to an approved waste receptor.

4. Exposed plumbing piping on room wall or ceiling shall be avoided. Insulate all water and drain lines immediately outside room for a minimum of 5-feet from room wall exterior surface.

I. Accessories

1. Controlled environmental room contractor shall provide all additional components and accessories required for a complete and operational installation.

2. All other products necessary for complete installation and operation shall be subject to the review of OUA and CPMG.

J. Sensors

1. If inert gases such as CO2 are utilized in the Controlled Environmental Room, oxygen sensors shall be provided to alert the users if a low oxygen condition occurs.

K. Fire Suppression

1. Fire suppression shall be provided above the enclosure and inside the enclosure in accordance with the ASU Fire Marshall's Office.

11 82 26 - Refuse Compactors

General

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.

All items shall be stored in an enclosed shelter providing protection from damage and exposure to the elements.

Products

A. Minimum of 2 compactors are required at each site: 1 landfill/ 1 recycling + space accommodation for organics collection.

1. Warranty 3 years.
2. Compactor Type Self-contained.
3. Doghouse: Site-specific.
4. Doors: Metal, double, magnetic latch.
5. Charge Box Capacity: 2 – 4 cu.yd.
6. Color: Blue recycle; beige trash.
7. Pressure Gauge: Color-coded.
8. Rear Box Capacity: 15 – 34 cu. yd.
9. Rear Box Type: Wet trash/Dry recycling.
10. Power: Solar with 3-phase, 10H, 280 volt.
11. Cycle: Multi.
12. Roller Plates: Required.
13. Guide Rail: 15' with stops.
14. Install: Yes.
15. Manufacture local: Closest possible.
16. PC/R Content: Highest possible.
17. Odor control: Sonozaire (or equal) odor neutralizer – trash.
18. Monitoring Equipment: Capable.

B. Compactor shall be sized in coordination with ASU Zero Waste and shall be as manufactured by Marathon, or equal.

C. 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 un-crushable 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.

D. 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.

E. 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.

F. Hydraulic cylinder shall be per model specified.

G. Compactor shall be constructed of heavy steel plate, welded and bolted together to form one continuous element.

H. 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.

I. 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 Beige.

J. 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.

K. Manually operated, lever actuated locking device shall secure container to both sides of the 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 are slant-topped to allow dumping by front-end loaders.

DIVISION 12 - FURNISHINGS

12 20 00 - Window Treatments

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 Design Professional (DP), not the IDC. All window openings other than lobbies or corridors shall have window coverings. Mini Blinds and other window treatments are to be purchased and installed under a Statewide purchasing agreement by ASU. The DP is to work carefully with the Project Manager (PM) to select an appropriate item for the intended use.The DP is to include in the documents and specifications instructions adequate to require the Contractor to provide for the selected treatment in construction activities (backing etc) as well as to coordinate the work of the Owner in installing the product. The Contractor is to protect the window treatment from the time that it is installed until construction is accepted by the Owner. Installations with damage caused by the Contractor after installation by ASU will be replaced by the Contractor at no cost to the Owner.

Design Standard

A. Interior window assemblies shall be designed to accept 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., Levolor Lorentzen, Inc.; or manufacturers which have equivalent quality. Coordinate with ASU Purchasing.

E. Classroom and laboratory uses may require enhanced window treatment. These treatments include motorized variable light reduction screens to total black out screens. In these instances, the DP is to work closely with the PM to determine the program requirement and to verify whether or not the item may be obtained under the ASU purchasing agreements. If not, the DP is to design and specify the item in the normal manner. If the item is to be procured and installed by the Owner, the process will be the same as for mini-blinds which is described above.

12 35 53 - Laboratory Casework and Other Furnishings

Revised 2022

Description

The use of modular or standardized, adjustable-height lab benches are required wherever possible to allow for reconfiguration.

Laboratory design and specifications must be developed with guidance from representatives of OUA and CPMG.

A. **SECTION INCLUDES**

1. Metal Laboratory Casework, and Casework Systems
2. Cabinet Hardware
3. Countertops and Sinks
4. Accessories
5. Mobile Base Cabinets
6. Movable Tables
7. Movable Laboratory Bench System
8. Wall Mounted Casework
9. Electronics Benches
10. Stainless Steel Lab Casework
11. Flammable Storage Cabinets
12. Corrosives Storage Cabinets
13. Slotted Channel Framing
14. Ceiling Service Panels
15. Peg Boards
16. Grommets and Accessories
17. Cylinder Restraint Assembly
18. Blackout Curtain and Track Assembly
19. Water and Laboratory Gas Service Fittings
20. Electrical Service Fittings

B. **RELATED SECTIONS**

1. Undercounter Flammable Storage Cabinets, refer to Section **11 53 13** Fume Hoods and Other Air Containment Units.

2. Undercounter Corrosives Storage Cabinets, refer to Section **11 53 13** Fume Hoods and Other Air Containment Units.

3. Vacuum Pump Cabinets, refer to Section **11 53 13** Fume Hoods and Other Air Containment Units.

4. Lattice Rod Assemblies, refer to Section **11 53 13** Fume Hoods and Other Air Containment Units.

C. **WORK INCLUDES**

1. Furnish and install metal laboratory casework including, but not limited to, counter tops, shelving assemblies, laboratory sinks, strainers, overflows and sink outlets with integral or separate pieces, service fittings where part of the laboratory casework, support framing, reagent shelves, standards, slotted studs, filler panels, scribes, knee space panels, accessories, utility space framing, utility space closure panels between base cabinets and at exposed ends of utility spaces and miscellaneous items of equipment as described in these guidelines and as shown on drawings, including delivery to the building, unpacking, setting in place, leveling and scribing to walls and floors as required.

2. Furnish and install the additional items listed above as described in these guidelines and included in the Construction Documents.

D. **Design Standard**

A. **MANUFACTURERS**

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Metal Laboratory Casework:

      1) Enterprise System by Kewanee Scientific Corporation
      2) Optima System by Mott Manufacturing
      3) Titan System by Air Master Systems Corp.

   b. Chemical-Resistant Plastic Laminates:

      1) Formica Corporation.
      2) International Paper; Decorative Products Division.
      3) Wilsonart Industries

   c. Epoxy Countertops, Sinks, and Troughs:

      1) Durcon Company, Inc. (Taylor, TX)
      2) American Epoxy Scientific. (Mountain Home, AR.)
      3) Kewaunee Scientific Corporation, (Statesville, NC.)

   d. Phenolic-Composite Countertops:

      1) Trespa North America, Ltd.
      2) Fundermax North America

   e. Wood: (Solid Laminated Wood)

      1) Bally Block Company, (Bally, PA.)
      2) Michigan Maple Block Company, (Petoskey, MI.)

2. The naming of a manufacturer and designation of a product is for the purpose of identifying a Basis of Design.

Other manufacturers capable of producing the same appearance and having the same quality, durability and performance may be proposed for use on this project subject to approval ofthe Owner’s Representative, prior to receipt of bids.

B. **CABINET MATERIALS**

1. Metal: Cold-rolled commercial steel sheet, complying with ASTM A 1008/A 1008M; matte finish; suitable for exposed applications.

2. Minimum Metal Thickness:

   a. Sides, ends, fixed backs, bottoms, tops, soffits, and items not otherwise indicated: 0.0478 inch (18 gauge). Except for flammable liquid storage cabinets, bottoms may be 0.0359 inch (20 gauge) if reinforced.

   b. Back side panels, doors, drawer fronts and bodies, and shelves: 0.0359 inch (20 gauge). For back panels and doors for flammable storage cabinets, use 0.0478 (18 gauge) inch thick metal. For shelves more than 36 inches long, use 0.0478 (18 gauge) inch thick metal or provide suitable reinforcement.

   c. Intermediate horizontal rails, table aprons and cross rails, center posts, and top gussets: 0.0598 inch (16 gauge).

   d. Drawer runners, sink supports, and hinge reinforcements: 0.0747 inch (14 gauge).

3. Glass for Glazed Doors: Clear laminated glass complying with ASTM C 1172, Kind LT, Condition A, Type I, Class I, Quality q3; with 2 lites not less than 3.0 mm thick and with clear, polyvinyl butyral interlayer.

C. **CABINET FABRICATION**

1. General: Assemble and finish units at point of manufacture. Use precision dies for interchangeability of like-size drawers, doors, and similar parts. Perform assembly on precision jigs to provide units that are square. Reinforce units with angles, gussets, and channels.Integrally frame and weld to form a dirt and vermin-resistant enclosure. Where applicable, reinforce base cabinets for sink support. Maintain uniform clearance around door and drawer fronts of 1/16 to 3/32 inch (1.5 to 2.4 mm).

2. Flush Overlay Doors: Outer and inner pans that nest into box formation, with full-height channel reinforcements at center of door. Fill doors with noncombustible, sound-deadening material.
3. Glazed Doors: Hollow-metal stiles and rails of similar construction as flush doors, with glass heldin resilient channels or gasket material.

4. Hinged Doors: Mortise for hinges and reinforce with angles welded inside inner pans at hinge edge.

5. Drawers: Fronts made from outer and inner pans that nest into box formation, with no raw metal edges at top. Sides, back, and bottom fabricated in one piece with rolled or formed top of sides for stiffening and comfortable grasp for drawer removal. Weld drawer front to sides and bottom toform a single, integral unit. Provide drawers with rubber bumpers, ball-bearing slides, and positivestops to prevent metal-to-metal contact or accidental removal.

6. Adjustable Shelves: Front, back, and ends formed down, with edges returned horizontally at front and back to form reinforcing channels.

   a. Adjustable shelves shall be 12” (300mm) and 15” (375mm) deep, as noted on drawings.

   b. Adjustable shelves shall be mounted to surface type steel standards (wall condition) or slotted studs (above peninsula benches). Adjustable shelves shall be supported by steel shelf brackets. Brackets shall be cold rolled steel with epoxy powder coated finish, complying with BHMA A156.9, Types B04102 and B04112. shelves shall be fastened to brackets with two stainless steel screws per bracket.

   c. Adjustable shelves mounted on slotted studs shall be supplied with a continuous 2” (50.8mm) high band to create a 1” (25.4mm) high curb at rear of shelf. The curb along the back shall be of similar material as the shelf.

7. Toe Space: Fully enclosed, 4 inches (100 mm) high by 3 inches (75 mm) deep, with no open gaps or pockets.

8. Table Legs: Welded tubing, 2” outside diameter, 11 ga. powder coated cold rolled steel outer leg with 1-3/4” outside diameter, 11 ga. powder coated cold rolled steel inner telescoping leg with 2” diameter nylon leveling glide 3/8” x 2-1/2” long. Height adjustment shall be from 30” to 37” (including work surface) in 1” increments.

9. Utilities: Provide space, cutouts, and holes for pipes, conduits, and fittings in cabinet bodies to accommodate utility services and their support-strut assemblies.

10. Utility-Space Framing: Laboratory casework manufacturer's standard steel framing units consisting of 2 steel slotted channels complying with MFMA-2, not less than 1-5/8 inches (41 mm) square by 0.0966 inch (2.5 mm) thick, and connected together at top and bottom by U- shaped brackets made from 1-1/4-by-1/4-inch (32-by-6-mm) steel flat bars. Framing units may be made by welding specified channel material into rectangular frames instead of using U-shapedbrackets.

11. Base Molding: Match architectural base molding.

12. Filler Strips and Utility-Space Closure Panels: Provide as needed to close spaces between cabinets and walls, ceilings, and indicated equipment. Fabricate from same material and with same finish as cabinets and with hemmed or flanged edges.

D. **CASEWORK SYSTEM**

1. General: Provide casework manufacturer's standard integrated system that includes support framing, fixed and movable casework units, filler and closure panels, countertops, and fittings needed to assemble system. System includes hardware and fasteners for securing support framing to permanent construction.

    a. Cabinets shall be fabricated as sectional units and be capable of being removed and reinstalled without use of special tools for relocation within system. Component parts of the unit shall be manufactured ensuring uniformity, interchangeability and accurate alignment. All base cabinets shall have integral enclosed bases.

    b. Base cabinets can be removed without removing or providing temporary support for countertops.

    c. Sinks shall be supported independent of base cabinets.

    d. Support framing has provision for fastening pipe supports at utility space in not more than1-inch (25-mm) increments.

    e. System includes filler and closure panels to close spaces between support framing, cabinets, shelves, countertops, floors, and walls, unless otherwise indicated. Fabricate panels from same material and with same finish as cabinets and with hemmed or flangededges.

    f. System includes wall-mounted casework that matches all other laboratory casework in design and material.

2. Task Lights. Task lights, with magnetic mounting strips, located under first shelf shall be suppliedand installed by casework manufacturer:

    a. Basis of Design as manufactured by Mocha Lighting, model Hero

    b. Gangable UL listed, low profile LED fixtures.

    c. Occupancy sensor

d. Integrated power supply requiring not external adapters.

3. Colors for Metal Laboratory Casework Finish: As selected by Architect from manufacturer's full range.

E. **CABINET HARDWARE**

1. General: Provide laboratory casework manufacturer's standard satin-finish, commercial-quality, heavy-duty hardware complying with requirements indicated for each type.

2. Hinges: Stainless steel, #4 finish, 5-knuckle hinges complying with BHMA A156.9, Grade 1, with antifriction bearings and rounded tips. Provide 2 for doors 48 inches (1200 mm) and less in height and 3 for doors more than 48 inches (1200 mm) in height, four for doors 84" or more in height. Hinges shall be capable of supporting a 150lb. Dynamic load, 100 lbs. On each side of thedoor located 12" from the hinge.

3. Drawer, Door and Pull Out Board Pulls. Door and drawer pulls shall be 4 inch (101.6mm) wire type, satin chrome plated finish, fastened from the back with two screws. Drawer and pullout board pulls shall be installed horizontally, door pulls shall be installed vertically. Wall cabinet and floor storage cabinet pulls should be located for reaching convenience and ADA accessibility guidelines. Two pulls shall be required on all drawers over 24 inches wide.

4. Door Catches: Nylon-roller spring loaded, self-aligning, catch with a steel strike plate. Double doors without locks shall have a catch on each door. Tall cases shall have latching devices located on the structurally fixed center shelf. The left hand door shall have a positive catch and the right hand door shall have a roller type catch. Where locks are used, catches and strike platesshall be used on left hand doors of double door cases and shall be steel, cadmium plated. Provide 2 catches on doors more than 48 inches (1200 mm) in height.
5. Drawer Slides: Powder-coated, full-extension, self-closing, heavy-duty, zinc plated drawer slides;designed to prevent rebound when drawers are closed; with nylon-tired, ball-bearing rollers; complying with BHMA A156.9, Type B05091, and rated for 100 lb at full extension and 150 lb for file or bin drawers, dynamic load and manufactured by Precision Slide, Accuride, Knape and Voght or Waterloo. Drawer slides shall have an integral stop mechanism to avoid inadvertent removal.
6. Label Holders: Stainless steel, aluminum, or chrome plated; sized to receive standard label cardsapproximately 1 by 2 inches (25 by 50 mm), attached with screws or rivets. Provide where indicated.

7. Locks: Cam or half-mortise type with 5-pin tumbler, brass with chrome-plated finish; complying with BHMA A156.11, Type E07281, E07111, or E07021. Locks shall be mounted in special housing so designed as to prevent removal when in locked position. The locks and lock housings shall be fully concealed within the drawer heads and doors. The lock tongues shall engage the rails or stiles when in locked position. Sliding door locks shall be push-type operating in sleeves and engaging both doors when in locked position and provided with positive door holding device. Install theft panels above each drawer or cupboard segment in order to isolate locked section. Locks shall be separately keyed (including cabinets with multiple locks and cabinets in the same room).

   a. Provide minimum of two para-centric keys per lock and two master keys.

   b. Provide where indicated.

   c. The exposed face shall be chromium plated with satin finish.

8. Sliding-Door Hardware Sets: Laboratory casework manufacturer's standard, to suit type and sizeof sliding-door units.

9. Toe space filler. At gap created between the cabinet or ledge static panel and the floor due to leveling conditions, mechanically fasten (flat head screw) a 4" (101.6mm) wide 18 gauge (1.21mm) galvanized steel plate to the cabinet behind the base molding to support its application.Provide continuous clear silicone sealant

at intersection of floor/wall and steel plate.

10. Shelf Adjustment. Adjustable shelf support clips inside wall, floor and base cabinets shall be designed for adjusting shelves on 2” (50mm) centers and shall be plated steel complying with BHMA A156.9, Type B04013. Clip shall be configured to clamp top and bottom of shelf to avoid movement. Clip may have one or two pins. In addition to shelf clips required for initial assembly, six (6) dozen additional clips to be provided to the owner.
11. Standards: Surface mounted adjustable shelves, shall be mounted to twin-tracked standards. Standards shall be coated with an epoxy powder coating complying with BHMA A156.9 Types B04102 with a nominal cross section of 1-1/2” x ½” (38.1mm x 12.7mm). Acceptable manufacturers shall be Reeve, Fixture Hardware Manufacturing Corporation, and Knape and Vogt. Standards and slotted studs shall have a fully compatible slot pattern. Fasten standards toconcrete masonry walls or properly blocked steel studded walls with appropriate flat head screws.Adjustable shelves, wall cabinets and pegboards will be furnished with integral mounting bracketsor clips.

12. Slotted Studs: Adjustable shelves, wall cabinets and peg boards mounted above peninsula or island benches shall be mounted to a welded double-sided, twin tracked stud assembly. Assembly shall be fabricated of 14 gage, fully welded steel tube with slots laser cut into uprights and be coated with an epoxy powder coat. Acceptable manufacturers shall be Reeve, Fixture Hardware Manufacturing Corporation, and Knape and Vogt. Slotted studs and standards shall have a fully compatible slot pattern. Adjustable shelves, wall cabinets and pegboards shall be furnished with integral mounting brackets or clips.

13. File Drawers. File drawers shall be furnished with Pendaflex metal inserts to hold files in a front- to-back configuration. File drawer shall be notched appropriately to accept metal inserts.

14. Grommets. Refer to Grommets and Accessories section below.

15. Adjustable Leveling Devices: Each base cabinet shall have leveling devices, 3/8”-16, 2.5” long similar to model # 2500T32 as manufactured by McMaster-Carr Supply Company, New Brunswick, NJ.

F. **COUNTERTOPS AND SINKS**

1. Countertops, General: Provide units with smooth surfaces in uniform plane free of defects. Make exposed edges and corners straight and uniformly beveled. Provide front and end overhang of 1 inch (25 mm), with continuous drip groove on underside 1/2 inch (13 mm) from edge. Curbs shall be of the same material as the counter tops. The gap between the curb and the wall shall be sealed with silicone sealant, color matching the counter top. Sink counter tops shall be fabricated in one piece and have a marine edge around the four sides to create a dished top. Counter tops shall be cut to maximum lengths possible.

2. Sinks, General: Provide laboratory casework manufacturer's closest standard size of equal or greater volume, as approved by Architect.

    a. Outlets: Provide with strainers and tailpieces, NPS 1-1/2 (DN 40), unless otherwiseindicated.

    b. Overflows: For each sink provide overflow of standard beehive or open-top design with separate strainer. Height 2 inches (50 mm) less than sink depth. Provide in same material as strainer.

3. Epoxy Countertops and Sinks: Factory molded of modified epoxy-resin formulation especially compounded and cured to give optimum physical and chemical resistant qualities. Material shall be a uniform mixture throughout the full thickness with a smooth, non-specular finish. Exposed edges shall have a 1/8th inch (3.18mm) radius on front top edge and at vertical corners. Curbs shall typically be 4 inch high, unless otherwise noted and shall be 3/4inch (19mm) thick bonded tothe surface of the top to form a square joint. Epoxy resin tops shall be 1 inch (25mm) for tables and benches. Joints between tops shall be smooth, even, 1/16 inch (3mm) wide, maximum and shall be watertight by use of a silicone adhesive with corrosive resistant quality. Epoxy resin counter tops shall be made with a separate service strip to accept service fixtures. Providemarine edges at all sink locations.

a. Physical Properties:

1) Flexural Strength: Not less than 10,000 psi (70 MPa).
2) Modulus of Elasticity: Not less than 2,000,000 psi (1400 MPa).
3) Hardness (Rockwell M): Not less than 100.
4) Water Absorption (24 Hours): Not more than 0.02 percent.
5) Heat Distortion Point: Not less than 260 deg F (127 deg C).

b. Chemical Resistance: Epoxy-resin material has the following ratings when tested with indicated reagents according to NEMA LD 3, Test Procedure 3.4.5:

1) No Effect: Acetic acid (98 percent), acetone, ammonium hydroxide (28 percent), benzene, carbon tetrachloride, dimethyl formamide, ethyl acetate, ethyl alcohol, ethyl ether, methyl alcohol, nitric acid (70 percent), phenol, sulfuric acid (60 percent), and toluene.
2) Slight Effect: Chromic acid (60 percent) and sodium hydroxide (50 percent).

c. Color: Dark Gray.

d. Countertop Fabrication: Fabricate with factory cutouts for sinks and with butt joints assembled with epoxy adhesive and pre-fitted, concealed metal splines. Field cutting or drilling will not be permitted.

1) Countertop Configuration: Flat,1 inch (25 mm)] thick, with beveled edge and corners, and with drip groove and integral coved backsplash.
2) Countertop Configuration: At sinks, raised (marine) edge, 1-1/4 inches (32 mm)] thick at raised edge, with beveled edge and corners, and with integral coved backsplash.

e. Sink Fabrication: Molded in 1 piece with smooth surfaces, coved corners, and bottomsloped to outlet; 1/2-inch (13-mm) minimum thickness.

1) Provide with polypropylene strainers and tailpieces.
2) Where noted, provide sinks for drop-in installation with 1/4-inch- (6-mm-) thick lip around perimeter of sink.

4. Phenolic Countertops and Sinks: Panels shall be of material specifically designed for laboratory work surfaces with a hardened acrylic surface and cured to give optimum physical and chemical resistant qualities. Material shall be a uniform mixture throughout the full thickness with a smooth, non-specular finish. Exposed edges shall have a 1/8th inch (3.18mm) radius on front top edge and at vertical corners. Curbs shall typically be 4 inch high, unless otherwise noted and shall be 3/4inch (19mm) thick bonded to the surface of the top to form a square joint. Phenolic tops shall be 1 inch (25mm) for tables and benches. Joints between tops shall be smooth, even, 1/16 inch (3mm) wide, maximum and shall be watertight by use of a silicone adhesive with corrosive resistant quality.

a. Physical Properties:

1) Compressive Strength: 24000 psi (165 MPa) minimum.
2) Modulus of Elasticity: 1.5 x 10^6 psi (10.3 GPa) minimum.
3) Shear strength: 2000 psi (14 MPa) minimum.
4) Water Absorption: 3 percent maximum.
5) Service temperature: 350 degrees Fahrenheit (177°C) maximum.

b. Chemical Resistance: Phenolic material has the following ratings when tested for 24 hours.

1) No Effect: Acetic acid (98 percent), acetone, ammonium hydroxide (28 percent), benzene, carbon tetrachloride, Chromic acid (60 percent), dimethyl formamide, ethyl ether, methyl chloride, nitric acid

(70 percent), phenol (90%), sodium hydroxide (60 percent), sulfuric acid (77 percent), and toluene.

c. Color: Dark Gray.

d. Countertop Fabrication: Fabricate with factory cutouts for sinks and with butt joints assembled with epoxy adhesive and pre-fitted, concealed metal splines. Field cutting or drilling will not be permitted.

1) Countertop Configuration: Flat,1 inch (25 mm)] thick, with beveled edge and corners, and with drip groove and integral coved backsplash.
2) Countertop Configuration: At sinks, Cutouts for drop-in sinks shall be routed to form openings with 3/8 inch (10 mm) minimum depth supporting flanges and such that the rims of the installed sinks are 1/8 inch (3 mm) below the surrounding work surface level or bottom of drain grooves, if present. The top edge of the cutout shall have 1/8 inch (3 mm) bevel. Epoxy sinks shall be set in beds of epoxy adhesive. Stainless steel and polypropylene sinks shall be set in beds of clear silicone sealant.

e. Sink Fabrication: Molded in 1 piece with smooth surfaces, coved corners, and bottomsloped to outlet; 1/2-inch (13-mm) minimum thickness.

1) Provide with polypropylene strainers and tailpieces.
2) Where noted, provide sinks for drop-in installation with 1/4-inch- (6-mm-) thick lip around perimeter of sink.

5. Chemical Resistant High-Pressure (Plastic) Laminate: High-pressure chemical resistant laminate, meeting or exceeding NEMA Standard LD3 2005 Grade HGP, HGL, or HGS requirements, consisting of a resin formulation applied over the decorative surface paper to achieve chemical resistance. The decorative paper shall be treated with melamine resin, and the core shall consist of kraft papers impregnated with phenolic resin. Sheets shall be bonded under high temperature and pressure.

6. Stainless Steel: Refer to Stainless Steel Fabrications and Lab Casework and Furnishings section of this Guideline.

7. Wood (Solid Laminated Wood):

a. Edge grain maple laminations with edge grain exposed.

b. Thickness: 1¾ inch (44 mm)

c. Composed of solid hard maple strips 1¾ inches (44 mm) wide, glued with water-resistant resin under heavy pressure side to side and end to end.

d. Curbs and splashes to be ¾ inch (18mm) thick matching material, 4 inches(100mm) high.

e. Round top edges and corners. Plane and sand smooth all surfaces.

f. Provide full-length, one-piece tops and backsplashes wherever possible, and keepfield joints to an absolute minimum.

g. Finish:

1) Finish with two coats of boiled linseed oil, well rubbed into all surfaces.
2) Finish with three coats of moisture and chemical resistant varnish coatingapplied to all surfaces and edges. Fine sand between coats.

G. **ACCESSORIES**

1. Reagent Shelves: Provide as indicated, fabricated from same material as adjacent countertop, unless otherwise indicated.

2. Adjustable Wall Shelf Supports: Mounted on surface-type steel standards (wall condition) or slotted studs (above peninsula benches). Shelves shall be supported by, cold rolled steel, shelf brackets. Brackets shall have an epoxy powder-coated finish, complying with BHMA A156.9, Types B04102 and B04112. Shelves shall be fastened to brackets with two stainless steel screwsper bracket.

3. Adjustable shelves mounted on slotted studs shall be supplied with a continuous 2 inch (50.8mm) high band to create a 1 inch (25.4mm) high curb at the rear of the shelf. The curb along the back shall be of similar material as the shelf.

4. UMBILICALS (Only located at center open benches with sinks)

    a. Vertical service columns shall extend from the counter top to a minimum of 6” (150mm) above the hung finished ceiling and secured at bottom and top to insure structural stability.

    b. Umbilical shall be fabricated and finished the same as the laboratory casework. Color to be selected by Architect.

    c. Umbilicals shall have a removable access panel, screwed in place, on unobstructed side. One unobstructed side (opposite side with conduit cut-outs).

    d. Provide 4” (152mm) high curb around umbilical of the same material as counter top with corners mitered. Provide cut-out in counter top centered under the service column to accommodate services from above as indicated on the Drawings. Coordinate and provide cut-outs on face of umbilical for feeds to electrical raceway and panel mounted fixtures.

H. MOBILE BASE CABINETS

1. Mobile Base Cabinets: Cabinets with casters or otherwise noted must incorporate the construction requirements listed below.

2. Base cabinet shall be nominally 34-1/2 inches high. Mobile base cabinets shall have ½” thick tops to match adjacent lab casework countertops. Mobile base cabinets shall have a finished 12 gage metal plate across the full bottom face of the cabinet through which casters shall be attached. Interior bolt heads for castersshall be countersunk.

3. Where noted on the drawings, cabinets with casters shall be constructed without toe spaces. The cabinet shall be constructed with a reinforced base capable of supporting a 4 inch (100mm) high caster assembly in each corner. Casters shall be swivel, locking type on front and swivel, non- locking type on rear, rated for minimum 50 pounds load each. Casters shall be equal to Algood soft rubber wheeled casters. The entire assembly shall be reinforced to permit mobility without twisting. Casters shall be through-bolted through bottom of cabinet at all four bolts and interior bolt heads shall be countersunk to conceal bolt heads. Allow sufficient clearance between top of cabinet and underside of work surfaces or apron to facilitate movement. Cabinets with casters shall be completely finished including 4mm edge banding on four sides, top and bottom since surfaces are considered exposed.

4. Drawer units shall have a minimum 45 lbs. counterweight in the rear of the unit to help prevent tipover of the cabinet.

I. MOVABLE TABLES

1. Movable tables shall be constructed as indicated on the Drawings.

2. Movable tables shall have 1.5” apron front and 7” sides and backs. It shall have 1” x 1” tubular ASTM 513, cold rolled steel telescoping legs fitted with a 1-1/2” diameter adjustable non-marring floor glides with 1” micro-adjustment capability.

3. Table Legs: Welded tubing, 2” outside diameter, 11 ga. powder coated cold rolled steel outer leg with 1-3/4” outside diameter, 11 ga. powder coated cold rolled steel inner telescoping leg with 2” diameter nylon leveling glide 3/8” x 2-1/2” long. Height adjustment shall be from 30” to 37” (including work surface) at 1” increments.

4. Movable tables shall be installed at height indicated on Drawings. Fixed section of leg shall be set at height appropriate for a 36” high table top and adjustable portion of leg shall be painted steel, drilled at 1” (25mm) increments. Coordinate the under-counter clearance with casework and refrigerators.

5. Movable tables shall be reinforced with a deep welded steel channel frame appropriate for the load bearing requirements. Load capacity of tables shall be 1,000 lb. (453.6kg) uniformly loaded and support a 250 lb. (113.4kg) concentrated load at mid-space with deflection not to exceed 1/8”(3.18mm).

6. Provide a countersunk metal slide plate with groves at underside of each leg and provide chainfor each pin support.

7. Provide a stretcher bar between the legs at the rear of unit.

8. Provide suspended drawer units where indicated on the drawings.

9. Movable table shall be equipped with a work surface as noted in the drawings.

J. **MOVEABLE LABORATORY BENCH SYSTEM**

1. General

   a. Finish: Chemical resistant urethane powder paint finish in custom color selected by Architect.

2. Work Surface Table Frame:

   a. Nominal table frame dimensions:

      1) Widths and Depths as indicated on the drawings
      2) Adjustable Height: 30” to 37” AFF including 1” thick work surface.

   b. Table Legs: Welded tubing, 2” outside diameter, 11 ga. powder coated cold rolled steel outer leg with 1-3/4” outside diameter, 11 ga. powder coated cold rolled steel inner telescoping leg with 2” diameter nylon leveling glide 3/8” x 2-1/2” long. Height adjustment shall be from 30” to 37” (including work surface) at 1” increments.
   c. Work surface frames to be 11 gage formed steel.

   d. Rear corners shall have 2.25” square x 6” high 11-gage collar. Front half of the collar shall be welded to the work surface frame with supporting gussets and the back half mechanically fastened to the rear uprights with socket head button cap and bolt.

   e. Back stop angle, with full length bumper, shall be located under the work surface frame toposition the 24” deep mobile base cabinet 1” behind the front edge of the work surface.

   f. Load Rating: 100 lbs per linear foot of width to maximum of 800 lbs. With 800 lbs of uniformly distributed load applied to an 8’ wide work surface, the maximum allowable deflection shall be .125” measured at the front center rail.

3. Rear Fame Support Structure

    a. Nominal dimensions:

        1) Width: As indicated on the drawings.
        2) Height: 84”

    b. Upright supports shall be 11 gage tubular steel 2” outside square dimension.

    c. Levelers are 3/8” – 16 NC x 2.5” long, similar to model # 2500T32 as manufactured byMcMaster-Carr Supply Company, New Brunswick, NJ.

    d. Rear frames: All units over 60” wide shall have a center support to accommodate splitupper shelving.

    e. Uprights have slots punched on 1” increments starting at nominal 55” above the floor tothe top of the upright.

    f. Upper and lower horizontal cross rails shall be 11 gauge steel.

    g. Lower structural cross rail shall support an integral two-channel raceway.

    h. Uprights to house lab gases services, electrical and data cables.

        1) Electrical cabling to be in a separate upright from gas piping.

    i. Lower cross rail shall house an electrical circuit raceway.

    j. Load Capacity: Rear Upright to support up to 3 shelves loaded to a maximum of 180lbs per 12” deep shelf. The total maximum load capacity for the Rear Upright is 540lbs.

4. Shelves:

    a. Shelves shall be constructed of powder coated cold rolled steel.

    b. Shelf brackets to be constructed of 14 ga. powder coated cold rolled steel.

    c. Vertical shelf adjustment in 1” increments.

    d. Load capacity shall be 30 lbs per linear foot.

    e. Shelf Types.

        1) Metal shelving
        2) Shelf Retainers: Shelves shall have a removable 18 gauge, powder coated, cold rolled steel back rail which acts as a back stop and can be turned upside down to provide a flush work surface with units are placed back-to-back.
        3) Upper shelf to have a removable 18 gauge steel back rail.

5. Plumbing Fixtures

    a. Provide a maximum of three plumbing services.

    b. Valves shall be stainless steel straight pattern instrumentation needle valves with serrated hose ends.

c. Plumbing lines shall be 0.25” OD x .035” wall thickness of 316 stainless steel tubing with quick disconnect attached to the tube with compression fittings at the top of the upright. Each half of the quick disconnect, coupler and nipple shall be valved.

d. The plumbing lines with the quick disconnects are to be arranged so services cannot be intermixed.

6. Service Connections

a. Power services shall have a 20-amp twist lock plug with a 4’ cord extension above thetop of the upright per upright.

b. Phone line wall have a female receptacle extending 4’ above the upright.

c. Data lines shall be furnished and installed by ASU as identified below:

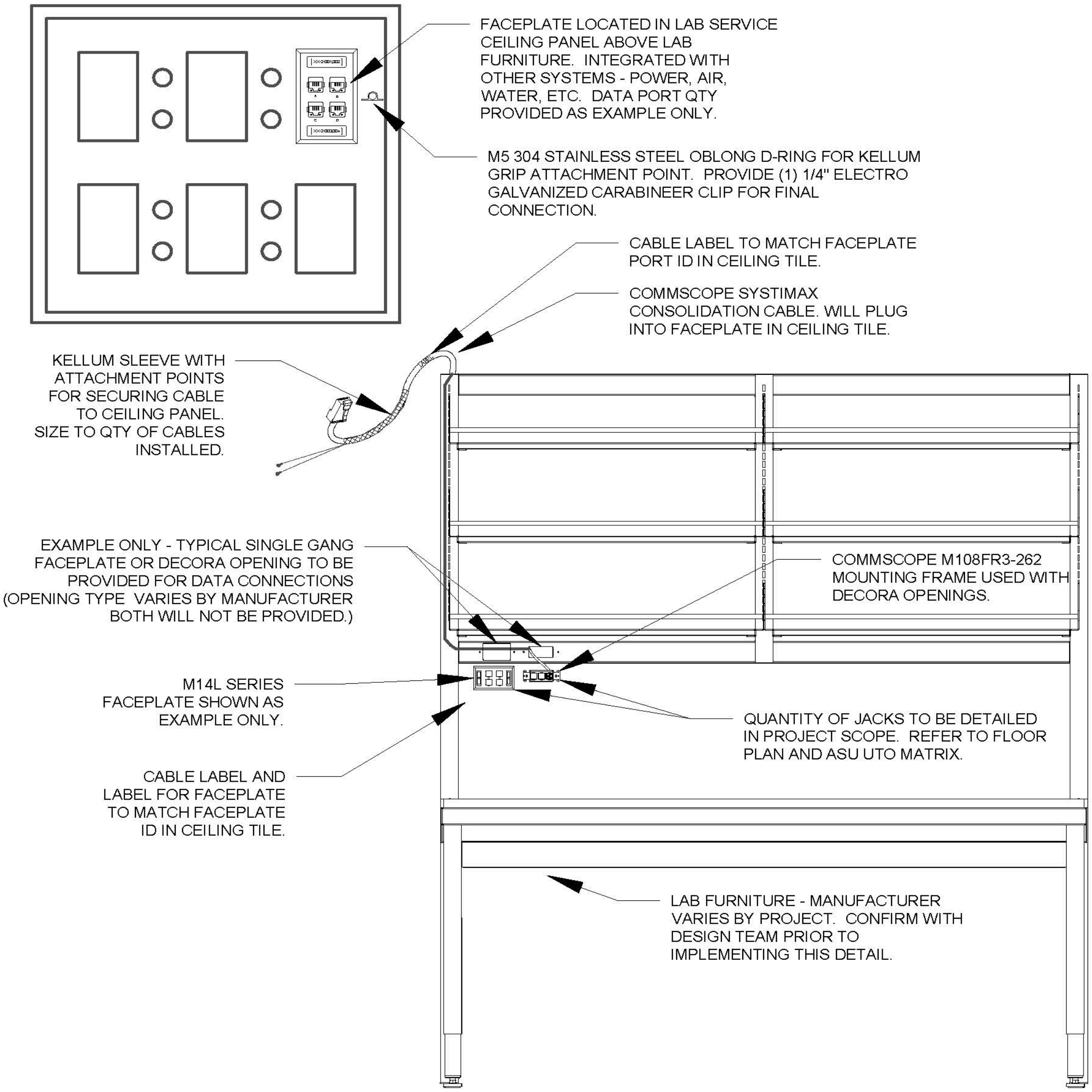
SCOPE OVERVIEW

ASU PROJECTS WILL NEED THE GC TO SHIFT ANY CABLING SCOPE FROM THE FURNITURE VENDOR TO THE SCS CONTRACTOR IN ORDER TO MAINTAIN THE CABLE INFRASTRUCTURE WARRANTY. ASU WILL REQUIRE THE SCS CONTRACTOR TO BUILD "CONSOLIDATION CABLES" FROM SOLID CONDUCTOR PATCH CABLES ORDERED IN CUSTOM LENGTHS, FROM COMMSCOPE SYSTIMAX, DOUBLED IN LENGTH OF WHAT IS REQUIRED, THEN CUT IN HALF, SO THEY CAN BE INSTALLED FROM THE OPENING AT THE TOP OF THE LAB FURNITURE, THRU THE FURNITURE TO THE TELECOMM OUTLETS PER THE DESIRED QTY. ENSURE UNTERMINATED END IS TERMINATED WITH A JACK AT THE OUTLET OPENING IN THE FURNITURE (IN THE FIELD BY THE SCS CONTRACTOR). AT THE TOP OF THE FURNITURE LEAVE 6'-10' OF SLACK WITH THE MALE CONNECTION (PRE-TERMINATED FROM THE FACTORY) TO PLUG INTO THE SERVICE PANEL IN THE CEILING. *NOTE THAT LENGTH WILL DEPEND ON DISTANCE FROM CEILING. A KELLUM GRIP (IDENTIFIED IN KEY NOTES ON THE TECHNOLOGY FLOOR PLANS, HOPEFULLY) WILL BE ADDED FOR STRAIN RELIEF.

A CABLE LABEL WITH UNIQUE IDENTIFIER INFO IS REQUIRED AT EACH END OF THE CABLE TO MATCH THE ASU MATRIX THAT COINCIDES WITH THE SERVICE PANEL OUTLET (IN CEILING) AND THE WORKSTATION OUTLET (AT THE LAB BENCH).

THE SCS CONTRACTOR WILL NEED TO COORDINATE THEIR EFFORTS WITH THE FURNITURE INSTALLER MUCH LIKE TYPICAL MODULAR SYSTEMS FURNITURE, IN ORDER TO PLACE CABLES AS THE LAB FURNITURE IS BEING ASSEMBLED.

TESTING WILL BE DIFFERENT IN THESE INSTANCES. FOR THESE LOCATIONS, THE CHANNEL TEST METHOD IN ADDITION TO THE PERMANENT LINK WILL BE UTILIZED. MEANING ONCE THE LAB FURNITURE IS IN PLACE WE WILL WANT A TEST FROM THE FACEPLATE OF THE LAB BENCH THRU TO THE PATCH PANEL. THE PATCH CABLES WILL NOT BE LEFT IN PLACE AS IS TYPICAL WITH THIS METHOD.



FACEPLATE LOCATED IN LAB SERVICE CEILING PANEL ABOVE LAB FURNITURE. INTEGRATED WITH OTHER SYSTEMS - POWER, AIR, WATER, ETC. DATA PORT QTY PROVIDED AS EXAMPLE ONLY.

M5 304 STAINLESS STEEL OBLONG D-RING FOR KELLUM GRIP ATTACHMENT POINT. PROVIDE (1) 1/4" ELECTRO GALVANIZED CARABINEER CLIP FOR FINAL CONNECTION.

CABLE LABEL TO MATCH FACEPLATE PORT ID IN CEILING TILE.

COMMSCOPE SYSTIMAX CONSOLIDATION CABLE. WILL PLUG INTO FACEPLATE IN CEILING TILE.

KELLUM SLEEVE WITH ATTACHMENT POINTS FOR SECURING CABLE TO CEILING PANEL. SIZE TO QTY OF CABLES INSTALLED.

EXAMPLE ONLY - TYPICAL SINGLE GANG FACEPLATE OR DECORA OPENING TO BE PROVIDED FOR DATA CONNECTIONS (OPENING TYPE VARIES BY MANUFACTURER BOTH WILL NOT BE PROVIDED.)

COMMSCOPE M108FR3-262 MOUNTING FRAME USED WITH DECORA OPENINGS.

M14L SERIES FACEPLATE SHOWN AS EXAMPLE ONLY.

QUANTITY OF JACKS TO BE DETAILED IN PROJECT SCOPE. REFER TO FLOOR PLAN AND ASU UTO MATRIX.

CABLE LABEL AND LABEL FOR FACEPLATE TO MATCH FACEPLATE ID IN CEILING TILE.

LAB FURNITURE - MANUFACTURER VARIES BY PROJECT. CONFIRM WITH DESIGN TEAM PRIOR TO IMPLEMENTING THIS DETAIL.

1 UTO ASU LAB BENCH DATA CABLE TO CEILING SERVICE PANEL TERMINATION DETAIL

SCALE: N.T.S.

7. Task Lights. Task lights, with magnetic mounting strips, located under first shelf shall be suppliedand installed by casework manufacturer:

   a. Basis of Design as manufactured by Mocha Lighting, model Hero

   b. Gangable UL listed, low profile LED fixtures.

   c. Occupancy sensor

   d. Integrated power supply requiring not external adapters.

8. Service Line Assembly

   a. Tubing: Polyurethane tubing shall be 3/8 inch O.D. with a 1/4 inch I.D. rated for 170 psi working pressure. Provide a 316L stainless steel fitting both ends.

   b. Quick-Disconnect Couplers: Keyed, color coded, 316L stainless steel mechanical quick disconnect couplings (sockets and plugs) shall be used to connect between the Ceiling Service Panel and the Movable Table. Couplers shall connect only with properly keyed mate and be color-coded to identify different key combinations. Each half of the quick disconnect couplers (socket and plug) shall be valved.

K. **WALL MOUNTED CASEWORK**

1. Where noted as such, provide wall-mounted casework that matches all other laboratory caseworkin design and material. The assembly's construction however, must be modified to withstand the rigors of being mounted directly to the wall and suspended above the floor, without sagging or effecting the door or drawer operation. The assembly must be capable of supporting an equipment load of at least 150 lb. (68.04kg) per running foot (304.8mm) above and beyond the weight of the assembly.

2. For additional design and planning of laboratory casework systems, please refer to the "Laboratory Guidelines" https://www.asu.edu/fm/documents/project_guidelines/Laboratory-Guidelines.pdf.

L. **ELECTRONICS BENCHES**

1. Manufacturers: Products complying with this specification may be provided by the following manufacturers. All products specified in this section shall be the provided by a single manufacturer.

   a. Electronic Tech Bench, Edsal Manufacturing Company, Inc., (Chicago, IL).

   b. RTW Table, Production Basics, Inc., (Billerica, MA).

   c. Technical Workstation, Tennsco, (Dickson, TN).

   d. Approved equivalent.

2. Characteristics:

   a. Dimensions: As indicated on the Laboratory Furnishing drawings.

   b. Materials: Table structure constructed of minimum 16 gauge steel.

      1) Finish: Electrostatically applied epoxy powder coating.
      2) Color: As selected by the Architect.

   c. Work Surface: 1-1/4 inch-thick, electro-static-dissipative (ESD) plastic laminate on industrial-grade particleboard core.

d. Upper Shelf: 1-1/4 inch-thick, electro-static-dissipative (ESD) plastic laminate on industrial-grade particleboard core, supported by risers units at each side, or legs at each corner.

e. Load Capacity of Worksurface and Shelf: 40 pounds per square foot.

f. Electrical:

1) Provide a minimum of (6) 120 V duplex outlets below the shelf and not obstructing the work surface. Outlets can be on the riser units, or within anintegrated raceway directly below the upper shelf.
2) Provide master on/off switch.
3) Provide a 96 inch long minimum power cord with NEMA 5-20 plug.
4) Provide ground wire for each ESD surface.

3. Accessories:

a. Drawer unit with one 12-inch-deep drawer, one 6-inch-deep drawer, and one pull- out writing shelf.

b. Articulating flat-screen monitor arm.

c. CPU Holder

M. **STAINLESS STEEL FABRICATION AND LAB CASEWORK:**

1. Applicability: This section applies to stainless steel fabrications, including, but not limited to, work surfaces, canopy hoods, low slotted exhaust, drying racks, shelves, autoclave/equipment enclosure walls and panels, sinks and scullery sinks, stainless steel pipe drop enclosures, and other miscellaneous brake-formed and shop fabricated stainless steel components and trim.

2. Manufacturers:

a. The Diamond Group, (Quebec H7S 1A9 Canada)

.

b. Inter Dyne Systems, Inc., (Shores, MI)

c. Kloppenberg & Co., (Englewood, CO)

.

d. Approved equivalent.

3. Materials and Finishes:

a. Unless otherwise noted stainless steel shall be Type 316 for horizontal surfaces and Type 304 for vertical surfaces; and shall be of gauge indicated on Laboratory Furnishing drawings or this specification.

b. All fabrications shall have exposed surfaces ground and polished to a No. 4 satinfinish.

c. 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 No. 4 finish.

d. All stainless steel welding material shall be of type similar to the sheet material ora richer quality. All welds shall be made without discoloration and shall be ground,polished, and passivated to blend harmoniously with a No. 4 satin finish. All jointsin stainless steel tops and work surfaces shall be welded.

4. Work Surfaces:

a. Thickness: 16 gauge (1.6 mm).

b. Fabrication:

   1) Edges: Flanged down the same dimension as the adjacent non-stainless top, with 1 inch (25 mm) being a minimum and returned over a perimeter metal frame to simplify securing top material to cabinet or structural frame.
   2) Reinforcement: Under-surface shall be reinforced with full length 16 gauge (1.6 mm) structural metal channels as required to insure rigidity and prevent buckling, warping, or oil canning. Where bench-mounted fittings are indicated on the drawings, provide top reinforcement to allow for rigid,secure mounting of fittings.
   3) Undercoating: Underside of top shall have a heavy mastic agent coating providing sound deadening.
   4) Stainless steel sides and backsplashes, where indicated, shall be integrally welded to top and finish as indicated above. The back side of exposed backsplashes shall be finished to match front and sides.

      a) Provide all holes and cutouts as required for built-in equipment andmechanical and electrical service fixtures. Verify size of opening with actual size of equipment to be used prior to making openings. Form insidecorners to a radius of not less than 1/8 inch (3 mm). After sawing, rout andfile cutouts to ensure smooth, crack-free edges with no burrs.

   5) Tops with Sinks: Tops and sinks shall be integral, fabricated with a marine edge and shall be pitched to sink bowl for proper drainage. Marine edges shall be seamless die-formed.
   6) Flat Stainless Steel Work Surfaces: (Without marine edge or sink) Shall have an integrally coved backsplash and bull-nose at front edge of work surface.
   7) Wall-Supported Benchtop

      a) Benchtops shall be fabricated as per construction section of this specification with stainless steel wall support and bracket angles all as perLaboratory Furnishings Drawings.
      b) Unit shall be designed to support 200 pounds per square foot, completelywall supported with no legs or support members extending to the floor.

   8) Joints: Fabricate work surfaces in the largest sections practical for delivery to the job site. All joints shall be field-welded, ground smooth, and polished on-site to create a continuous work surface.

5. Laboratory Sink: Integral one piece construction with stainless steel work surface.

   a. Thickness: 18 gauge (1.3 mm thick), unless otherwise noted.

   b. Construction: Sink units shall be designed and fabricated with sufficient reinforcement to prevent oil canning. All sink joints shall be butt-welded, ground smooth by the heliarc welding process. Inside radii shall be 1 inch (25 mm). Bottoms shall be pitched to the drain indent. No soldering will be permitted in connection with sink construction. Sink bowl dimensions given are inside dimensions. Underside shall have a heavy mastic agent coating providing sound deadening.

6. Scullery Sink: Stainless steel top with integral sink bowls in sizes as shown. The requirements for stainless steel tops and sinks described above shall govern in its entirety.Backsplash, marine edge and drain boards shall be provided as indicated in Laboratory Furnishings plans.

   a. Thickness: 14 gauge.

   b. Construction: Front, bottom and back of sink compartments shall be formed of onesheet of material with integral 1 ½ inch (40 mm) roll rim, extending full length at front and ends of compartments and drainboards. Compartment ends and partitions shall be electrically welded into place. Drainboards shall pitch from 2 inches at rolled rim and ends to 2 ½ inches (65 mm) below rim at compartments. Bottoms shall be pitched to the drain indent. Sink units shall be designed and fabricated with sufficient reinforcement to prevent oil canning. All sink joints shall be butt-welded, ground smooth by the heliarc welding process. Inside radii shall be 1 inch (25 mm). No soldering will be permitted in connection with sink construction. Sink bowl dimensions on drawings are inside dimensions. Undersideshall have a heavy mastic agent coating providing sound deadening.

c. Legs: Sinks shall be supported on stainless steel square tube legs with stainless steel leveling guides.

d. Accessories: Provide Elkay LK-86-RT, or approved, waste fitting at each compartment of stainless steel construction with strainer, overflow and lever handle. Provide tailpiece compatible with laboratory waste piping system. Refer to Division 22 for piping requirements.

e. Coordination: Coordinate scullery sink design with the requirements of any undercounter equipment (such as dishwashers and glassware washers), as shown on the Laboratory Furnishings drawings. Provide intermediate, end, and trim panels to enclose the undercounter portions of the scullery sink at equipment locations.

7. Canopy Hood: Provide stainless steel canopy with all hangers and miscellaneous hardware at locations and sizes as indicated on the Laboratory Furnishing drawings.

    a. Thickness: 18 gauge.

    b. Construction: Provide reinforcing necessary to prevent oil canning or deflection ofpanel between supports. All corners and joints shall be welded, ground smooth and free of all defects. Welded joints with visible burn marks will not be accepted.

    c. Accessories: Provide stainless steel hangers and miscellaneous support hardware as required for a complete installation.

    d. Provide dust-proof and vapor-proof light fixture with remote switch.

        1) Manufacturers: Products complying with this specification may be provided by the following manufacturers. All products specified in this section shall be the provided by a single manufacturer.

            a) Canplas Industries Ltd., (Barrie, Ontario, Canada)
            b) Approved equivalent.

                1) Basis of Design: Canplas Canlet Series Vaporproof Lighting, model No. 6802-FCF-21-00-39.
                2) Construction/Features:

                    - Corrosion-resistant glass reinforced polyester thermoplastic fixture with brass screws and inserts and electrical box for ceiling mounting; U.L. listed for wet locations.
                    - Globe: Prismatic opal polycarbonate with no guard or reflector.
                    - Grounding screw.
                    - Hub-to-hub grounding via an internal bonding frame.
                    - External and internal gaskets for a water-tight seal.

                3) Ballast: Electronic, 120-volt.
                4) Lamp: 26 watt compact fluorescent.
                5) Color: Stone Gray.

    e. Provide exhaust duct transition piece for mechanical connection above the ceiling Refer to the Exhaust Schedule on the drawings for required exhaust flow rate and connection diameter.

8. Low Slotted Exhaust:

    a. Thickness: 18 gauge (1.3 mm).

    b. Fabrication: Provide reinforcing necessary to prevent "oil canning." All corners andjoints shall be welded, ground smooth and free of all defects. Welded joints with visible burn marks will not be acceptable.

    c. Seal transition at adjacent surfaces with clear sealant.
    d. Extend exhaust enclosure to above ceiling for mechanical connection. Refer to Laboratory Furnishings drawings for details.

    e. Provide collar at ceiling for connection.

9. Stainless Steel Shelving System

    a. Manufacturers: Products complying with this specification may be provided by thefollowing manufacturers. All products specified in this section shall be the providedby a single manufacturer.

        1) InterMetro Industries Corporation, (Wilkes- Barre, PA)
        2) Eagle Group, (Clayton, DE)
        3) Nexel Industries Inc., March Equipment Inc., (Flanders, NJ)
        4) Approved equivalent.

N. **FLAMMABLE STORAGE CABINET:**

1 Manufacturers:

    a. Justrite Manufacturing Co., (Mattoon, IL)

    b. Eagle Manufacturing Co., (Wellsburg, WV)

    c. or Equivalent

2 Product Description: The FMO recommends that stand alone flammable storage cabinets be vented. **However**, if the flammable cabinet meets the following criteria venting is not required:

    a. Flammable Liquid Storage Cabinets must be constructed of steel.

    b. Minimum wall thickness shall be 0.044 inches (18 gauge).

    c. Double walled construction with a minimum air gap of 1-1/2-inches between the walls including the door, top, bottom, and sides.

    d. Tight-fitting joints, welded or riveted.

    e. Liquid-tight bottom with a door sill of at least 2 inches.

    f. Three-point latch on doors.

    g. Cabinet doors shall be self-closing and self-latching.

    h. Conforms to ULC standards, either:

        1) ULC–C1275 Storage Cabinets for Flammable Liquid Containers, or
        2) ULI 1275 Flammable Liquid Storage Cabinet.

i. Vent openings shall be sealed with the bungs supplied with the cabinet or with bungs specified by the manufacturer of the cabinet.

j. Label: "FLAMMABLE - KEEP FIRE AWAY" in conspicuous silk-screened lettering. Stick-on decals are not acceptable. Size and style of lettering shall match that of the Corrosives Storage Cabinet label.

k. Locks: Cabinet doors shall be lockable.

l. Floor pan: Provide a 2 inch deep liquid tight pan to cover the entire bottom of the cabinet to contain liquid leaks and spills.

m. Shelves: Provide heavy-duty shelves with reinforced edges and underside.

n. Standards: Comply with the requirements of OSHA and NFPA 30.

o. Comply with the requirements of the Uniform Fire Code with UL 1275 and FM 6050 labels.

p. Flammable liquid/solvent storage cabinets shall not be vented. Seal vent openings with bungs as provided by manufacturer.

q. Electrical grounding:

    1) Provide each flammable liquid/solvent storage cabinet with an externally mounted grounding conductor screw terminal for up to #8 AWG conductor, mounted at the top of the cabinet.
    2) The storage cabinet terminal shall be connected to the equipment grounding bus at the lab branch circuit panel.

O. **CORROSIVES STORAGE CABINET:**

1 Manufacturers:

a. Justrite Manufacturing Co., (Mattoon, IL)

b. Eagle Manufacturing Co., (Wellsburg, WV)

c. or Equivalent

2 Product Description:

a. Purpose-designed metal cabinet completely lined.

b. Lining: Cabinet shall be complete lined with a polypropylene or polyethylene liner with sealed or seamless intersections between panels. No metal of any type shall be exposed within the lined interior of the cabinet. Screw-heads, if required, shall be covered with hinged-type (not snap-on) plastic screw-head covers.

    1) Shelf: Removable full-depth polypropylene or polyethylene shelf.

c. Label: "CORROSIVES" in conspicuous silk-screened lettering. Stick-on decals are not acceptable. Size and style of lettering shall match the Flammable Liquid/Solvent StorageCabinet label.

d. Locks: Cabinet doors shall be lockable, except where noted on drawings.

e. Venting:

    1) Cabinets not below or adjacent to fume hoods: Provide and install 2 inch PVC ventpipe to run horizontally in the chase space behind the casework to nearest pipe drop enclosure and rise vertically to 6 inches above ceiling level. Connection shall be made to the exhaust duct system.

P. **SLOTTED CHANNEL FRAMING:**

1. Manufacturers: Products complying with this specification may be provided by the following manufacturers. All products specified in this section shall be the provided by a single manufacturer.

    a. Unistrut, (Wayne, MI)

    b. Cooper B-Line Inc. (B-Line), (Highland, IL)

    c. Kumar Industries (Nu-Strut), (Chino, CA)

    d. Power Engineering Co. (Powerstrut), (Shrewsbury, MA)

    e. Wesanco, Inc. (Westrut), (La Mirada, CA)

    f. Approved equivalent.

2. Materials: Channel and framing members shall be fabricated from steel conforming to thefollowing requirements:

    a. Framing Members:

        1) Concealed Framing Members and Fittings: ASTM A570 GR 33.
        2) Exposed Framing Members and Fittings: ASTM A446 GR A with zinccoating conforming to ASTM A525.
        3) Stainless Steel Framing Members and Fittings: ASTM A240 (Type 304),where indicated.

    b. Fittings:

        1) Concealed Fittings: Fabricate from steel satisfying the requirements of ASTM A570 GR 33, and conform to the following ASTM specifications: A575, A576, A36, or A635. Nuts shall conform to ASTM A576 GR 1015 and screws shall conform to SAE J429 GR 2 and ASTM A307.
        2) Exposed Fittings: Fabricate from steel satisfying the requirements of ASTM A570 GR 33, and conform to the following ASTM specifications: A575, A576, A36, or A635. Nuts shall conform to ASTM A576 GR 1015 and screws shall conform to SAE J429 GR 2 and ASTM A307. Exposed fittings shall receive zinc coating conforming to ASTM A525.
        3) Stainless Steel Fittings and Hardware: Sintered Nuts shall be of ASTM B783 (Type 316N2-33) stainless steel and fittings shall be of ASTM A240(Type 304) stainless steel. Stainless steel fittings and hardware shall be used with stainless steel framing members, or where indicated.

            a) Thickness: 12 gauge, unless noted otherwise.
            b) Size: 1 5/8 inch x 1 5/8 inch cross-section, unless noted otherwise.

3. Components:

    a. The following components are identified as the Basis of Design, unless otherwise noted:

        1) Framing Channel: 1 5/8 inch x 1 5/8 inch x 12 gauge: Unistrut P1000, Powerstrut PS 200, Kumar Industries N-200, B-Line Systems, Inc. B22, orequal.
        2) Suspended Framing Channel, 3 ¼ inch x 1 5/8 inch x 12 gauge: Unistrut P5000, Powerstrut PS 100, Kumar Industries N-150, B-Line Systems, Inc.B11, or equal.
        3) 90° Angle Fitting: 4 1/8 inch x 3½ inch x ¼ inch with two holes, each leg: Unistrut P1325, Powerstrut PS 607, Kumar Industries N-1123, B-Line Systems, Inc. B104, or equal.
        4) 135° Angle Fitting: 3 inch x 2 5/16 inch x ¼ inch with one hole, each leg: Unistrut P1546, Powerstrut PS 633-45°, Kumar Industries N-1425, B-LineSystems, Inc. B154, or equal.

5) T-Shaped Flat Plate Fitting: 5 3/8 inch x 3½ inch x ¼ inch plate, T-shaped,with four holes: Unistrut P1031, Powerstrut PS 714, Kumar Industries N- 1022, B-Line Systems, Inc. B133, or equal.
6) Wing Shape Fitting, 9 5/32 inch x 3 7/8 inch ten holes, two holes in each wing section and two holes in each of three channel section sides: UnistrutP2347, Powerstrut PS 913, B-Line Systems, Inc. B273.
7) Vertical Posts: 3¼ inch x 1 5/8 inch x 12 gauge, double channel section: Unistrut P1001, Powerstrut PS 200 2T3, Kumar Industries N-200-A, B- Line Systems, Inc. B22A, or equal.
8) Horizontal Support Members: 1 5/8 inch x 1 5/8 inch x 12 gauge framing channel with 13/32 inch x 3 inch slotted holes, 4 inches on center: Unistrut P1000 SL, Powerstrut P 200 S, Kumar Industries N-200-SL, B-LineSystems, Inc. B22S, or equal.
9) Slotted Hole Framing Channel, 1 5/8 inch x 1 5/8 inch x 12 gauge framingchannel with 13/32 inch x 3 inch slotted holes, 4 inches on center: Unistrut P1000 SL, Powerstrut P 200 S, Kumar Industries N-200-SL, B-LineSystems, Inc. B22S.
10) Slotted Framing Channel for installation in Chemical Fume Hoods, 1 5/8 inch x 13/16 inch x 16 gauge Type 316 stainless steel framing channel: Unistrut P4000 SS, Powerstrut PS 560 SS, Kumar Industries, B-Line Systems, Inc.

    - Attach channel to side of fume hood with 2 5/8 inch x 1 7/8 inch x1/8 inch, 4 hole, stainless steel 90º fitting: Unistrut P6325 SS, Powerstrut, Kumar Industries, B-Line Systems, Inc.

11) Diagonal Brace Supports: Framing Channel, 1 5/8 inch x 1 5/8 inch x 12 gauge: Unistrut P1000, Powerstrut PS 200, Kumar Industries N-200, B- Line Systems, Inc. B22, or equal.
12) Closure Strip: 0.04 inches thick snap-in cover for framing channel: Unistrut P3184, Powerstrut PS 6152, Kumar Industries N-1920, B-Line Systems, Inc. B217-24, or equal. Provide closure strips over all exposed vertical post sections.
13) End Caps: 0.06 inches thick for framing channel: Unistrut P1280, Powerstrut PS 707, Kumar Industries N-2500, B-Line Systems, Inc. B205,or equal. Provide end caps for all exposed horizontal framing channels.
14) Ceiling Escutcheon: Provide 18 gauge steel, finished to match framing members, as indicated on the Laboratory Furnishing drawings, at ceiling penetrations.
15) Other components, hardware, and fasteners, as required for a complete assembly and as indicated on the drawings.

b. Service Struts and Ledging:

1) 16 gauge, 13/16 inch x 1 5/8 inch cold-formed framing uprights: Unistrut P4000, Powerstrut PS 560, Kumar Industries N-400, B-Line Systems, Inc.B56, or equal. Uprights shall be provided at 48 inches, maximum, and fastened top and bottom by two adjustable U-shaped spreaders.
2) U-shaped spreaders: 12 gauge by 1½ inch (45 mm) wide by length required, galvanized steel.
3) Provide to support tops at pipe service chase space, support draintroughs, under fume hood superstructures, and other abnormal loads.
4) Support struts with U-shaped spreaders shall be provided at 48 inches (1220 mm) on center below island and peninsula benches. Support struts shall be provided along wall 48 inches (1220 mm) on center below island and peninsula benches. Struts will be used to support piped and electrical services. Provide all bolts,expansion sleeves, and fastening devices for a complete assembly including pipe and conduit hangers.

c. Heavy Duty Shelving:

1) Shelf Standards: Framing channel, spaced equally, 36 inches on center, maximum. Secure to wall. Provide all bolts and fastening devices for a complete assembly.
2) Brackets: Cold-formed framing channel brackets, as required formaximum cover of shelf depth:

    - Shelves at least than 9 inches and less than 11 inches deep: Unistrut P1769, Powerstrut PS 732-8, B-Line Systems, Inc. B187,or equal. Secure to steel uprights and underside of shelf with removable bolt fasteners

- Shelves at least than 11 inches and less than 13 inches deep: Unistrut P1771, Powerstrut PS 732-10, B-Line Systems, Inc.B541, or equal. Secure to steel uprights and underside of shelf with removable bolt fasteners.
- Shelves at least 13 inches and less than 15 inches deep: UnistrutP1773, Powerstrut PS 732-12, B-Line Systems, Inc. B289-12, or equal. Secure to steel uprights and underside of shelf with removable bolt fasteners.
- Shelves at least 15 inches and less than 17 inches deep: UnistrutP1775, Powerstrut PS 732-14, B-Line Systems, Inc. B289-14, or equal. Secure to steel uprights and underside of shelf with removable bolt fasteners.
- Shelves at least 17 inches and not exceeding 20 inches deep: Unistrut P1777, Powerstrut PS 732-16, B-Line Systems, Inc.B290, or equal. Secure to steel uprights and underside of shelf with removable bolt fasteners.

d. Finish:

1) Provide finish coating for all cold-formed framing components, except for stainless steel components.
2) Concealed Framing Members and Fittings: Rust inhibiting acrylic enamel paint applied by electrostatic deposition, after cleaning and phosphating, and thoroughly baked. Finish shall withstand a minimum of 400 hours saltspray when tested in accordance with ASTM B117. Color: Green.
3) Exposed Framing Members and Fittings: Factory applied epoxy powder coat. Color: To be selected by the Architect.

Q. **CEILING SERVICE PANELS:**

1. The Ceiling Service Panel (CSP) is a rigid mounting surface for laboratory utilities distributed along the centerline of a laboratory bench group. Panels are designed to accommodate standard junction boxes for electrical, voice, and data, as well as medical grade quick connect fittings for the distribution of specialty gases, compressed air, and vacuum. CSP is designed to fit most suspended t-bar grid ceiling systems. CSPs are specified in a 24” x 24” or 8”x 24” size. Location, details, and size as noted on drawings.

2. A CSP is used in conjunction with a steel frame laboratory table which is vertically adjustable. Utilities on the laboratory table connect to the CSP via cables incorporating twist-lock or flexible tubing with quick-disconnect fittings. Overhead utility supply from the CSP allows for flexibility andmobility of laboratory services without the need to penetrate floors and walls.

3. CSP shall be fabricated from 11-gage cold rolled steel with urethane or epoxy powder coated finish at 2’ x 2’ panels. CSP shall be fabricated from 14-gage cold rolled steel with urethane or epoxy powder coated finish at 8” x 24” panels. All four edges of each panel shall be flanged to a depth of 3/4 inch. Flanges shall have a maximum 1/16 inch radius and shall be welded at intersecting corners to improve rigidity. Height of the panel varies with the size of junction boxes and utility fittings attached. Panels shall be fabricated with openings and mountingholes for all junction boxes and utility fittings. Final finish shall be applied after all flanges, openings and holes are fabricated.

4. CSP will be detailed in the laboratory construction documents to include various combinations of utilities by group designation (CSP1, CSP2, etc…) to support a number of laboratory types and bench arrangements.

R. **PEGBOARDS:**

1. Basis of Design: Inter Dyne Systems “V” Victoria Series, modified as indicated on the drawings.

   a. Drying rack bodies shall be of one-piece design and of not less than 20 gauge (1.0 mm thick) Type 304 stainless steel with a No. 4 finish. The top shall have two 90-degree bends, and sides to have one 90 degree bend.

   b. Each rack shall have an integral full-width 20 gauge (1.0 mm thick), Type 304 stainless steel drip trough with stainless steel drain tube. Drip trough shall be continuously welded.

   c. The trough shall have a full-length, Type 304 stainless steel wire mesh screen insert. Screen insert shall be turned down on all four sides to provide a clean and finished appearance.

   d. Each rack front shall be dimensioned and punched with T-shaped holes to accommodate the peg arrangement shown on the drawings.

2. Pegs shall fit into the punched holes in the rack front. A T-shaped protrusion on the base of the pegs shall allow easy removal and replacement without the need for tools. The T-shaped holes shall be designed to fit the protrusion on support pegs for holding single or multiple utensil drip trays, drain shelves, funnel racks or pipette holders. Pegs shall be of injection-molded white polypropylene.

3. Provide wall hangers for each rack, designed to enable the removal and replacement of the entire rack for cleaning without the need for tools.

4. Provide stainless steel fixing screws of appropriate type for attachment to support structure.

5. Provide clear, tight-fitting hose to drain from drip trough drain tube into sink.

6. Provide finished stainless steel back panel when any portion of the back of drying rack is exposed.

7. Pegboards at umbilical shall be furnished with integral clips to attach to standards. Pegboard size and configuration shall be as indicated on the Drawings.

8. Provide continuous silicone sealant at intersection between pegboard and trough.

S. **GROMMETS AND ACCESSORIES:**

1. Round Grommets:

   a. Size: 2 3/8 inch (60 mm) O.D.

   b. Material: Plastic

   c. Accessories: Removable slotted plastic cover

   d. Color: To be selected by Architect.

   e. Basis of Design Model: Doug Mockett & Co., Inc. Model No. TG-3.

   f. Refer to plans for location.

   g. Manufacturers: Products complying with this specification may be provided by the following manufacturers:

      1) Doug Mockett & Company, Inc., (Manhattan Beach, CA)
      2) Häfele America Inc., (Archdale, NC)
      3) Approved equivalent.

2. Ventilation and Cord Slot Grommet

   a. Dimensions: 17 inches wide, 1 ¾ inches deep.

   b. Color: Black.

c. Basis of Design Model: Doug Mockett & Co., Inc. Model CP1 paper slot grommet.

d. Manufacturer: Doug Mockett & Co., Inc. (Manhattan Beach, CA)

e. Approved equivalent.

3. Utility Management Hook

a. Type 303 stainless steel hook with polished finish.

b. Size: 4 23/32 inch tall, 2 43/64 inch wide.

c. Load capacity: 22 pounds.

d. Basis of Design Model: McMaster-Carr Model No. 19075A12.

e. Manufacturer: McMaster Carr, (Los Angeles, CA)

f. Approved equivalent.

T. **CYLINDER RESTRAINT ASSEMBLY:**

1 Manufacturers:

a. Basis of Design: USA Safety

2 Product Description:

a. Cylinder restraint constructed from 11 gauge hot rolled steel:

1) 2-Cylinder Wall Mount Model #GB200FS
2) 3-Cylinder Wall Mount Model #GB300FS
3) 4-Cylinder Wall Mount Model #GB401FS

b. Straps: 1.5” polypropylene straps, 54” long, and steel cinch buckle
c. Include optional chain set.

d. Cylinder restraint edges protected with steel reinforced vinyl edge guarding.

e. Provide manufacturer’s standard acid resistant epoxy powder coat finish. Color to beselected by Architect.

3. Chain: Provide restrainers of 5/16 inch diameter, Type 304 stainless steel weldedchain fitted with stainless steel snap shackle with swivel clevis and split ring for each bracket; McMaster-Carr Supply Company, Suncor Marine & Industrial, Inc., or approved substitution.

4. Cylinder restraint steel components shall be factory-finished to match the casework metal color as selected for the project.

U. **BLACKOUT CURTAIN AND TRACK ASSEMBLY**

1. Manufacturers: Products complying with this specification may be provided by the following manufacturers. All products specified in this section shall be the provided by a single manufacturer. Basis of Design is by Aero Shade Co., Inc.

    a. Aero Shade Co., Inc., (Los Angeles CA)

    b. Ka-Lor Cubicle & Supply Co., (Fair Lawn, NJ)

    c. PL Systems, 65 Bethpage Rd., (Plainview, NY)

    d. Approved equivalent.

2. Curtain Materials and Fabrication:

    a. The blackout curtain material shall be of the following fabric composition: 38% SEF Modacrylic, 30% Saran Flat Monofilament, 26% Viscose Rayon and 6% Polyester. Material shall have a double-vinyl black color laminated back for opacity (submit samples).

    b. The curtain shall be sewn flat with 10% fullness. The seams shall be sewn French-style (no raw edges visible). The curtain top shall be grommeted on 8 inch (200 mm) centers. The bottom edge shall be weighted and overlap the floor approximately 2 inches (50 mm).

    c. The outside vertical edges shall be supplied with "Velcro" quick-seal strips to facilitate "light-trap" overlaps for easy light-tight attachment to walls.

    d. Curtain shall be supplied with minimum 11 inch (280 mm) high front and rear light-trap valances. The valances shall be made of the same black-out curtain materials, sewn flat (no fullness) with a sewn-on Velcro strip, and shall be mounted to the curtain track assembly using the "Light-Trap-Interface".

    e. Blackout curtain must be flame-retardant and self extinguishing, or made of non-combustible materials. Fabric must pass the flame resistance requirements specified in accordance with the National Fire Protection Association Standard No. 701-99 test methods 1 and 2. Submit certificate of passage to tests.

3. Track Material and Assembly:

    a. Construct of satin anodized extruded aluminum box-channel 1-3/8 inches x ¾ inch (35 x 18 mm) slotted on the underside to receive two wheeled carriers designed for surface mounting to the underside of the ceiling. The track shall also serve as an integral part of the valance assembly. Supply with hook carriers, end-caps, snap-outs, and connectors, of the sleeve type. Hooks are formed of rustproof wire and bead chain riding on a carrier with non-wearing nylon wheels. Corners, where required, shall be one-piece, 12 inch (305 mm) radius 90 degree track sections.

V. WATER AND LABORATORY GAS SERVICE FITTINGS

1. Manufacturers. Service fittings shall be manufactured by:

    a. WaterSaver Faucet Co

    b. Far Laboratories

    c. Broen Corporation

    d. Chicago Faucets

2. Laboratory service fittings and fixtures shall comply with SEFA 7, “Laboratory and Hospital Fixtures-Recommended Practices. Fixtures for liquids and gaseous mixtures shall have lettered and colored indexes for each service. Handles shall be white, with color tabs identifying utility. Serrated hose ends shall have seven (7) serrations. Fixtures for gas, air and vacuum shall be needle valve, large type. Water fixtures shall be compression type. Drain fittings shall be polypropylene unless otherwise noted. Fixtures that serve special

gases (N2, O2, NO2, etc.) and instrument air shall be lubricated, cleaned, capped protected, and delivered certified for “Oxygen”service.

a. Provide fittings complete with washers, locknuts, nipples and other installationaccessories necessary for final connection. Include the deck flanges, escutcheons, handle extension rods and similar items.

3. Materials: Plumbing fixtures, except for drain fixtures and fittings, shall be a forged red-brass composition containing at least 85% copper with washers and seats, of maximum wear resistant materials for the specific use. Reagent grade water fixture to be brass gooseneck type with an internal polypropylene lining that permits recirculation to the manual outlet.

4. Needle Valves (Large): Provide large needle valves with a renewable valve seat and floating cone made of stainless steel with removable serrated outlet.

5. Compression Water Valves: Provide units complying with ASME A112.18.1. Compression water valves shall have a renewable unit containing all working parts, including a stainless steelreplaceable seat and valve disc. Unit shall be broached on the outside for permanent position in the valve body. The unit shall contain an integral control device for volume of water discharged by the faucet. The valve shall have a removable serrated hose unless otherwise noted. Valve shall be rated for 125 psi (857 kPa) operating pressure with a max of 190 psi (1303 kPa) for intermittent use.

6. Faucet Accessories: Hot and cold water combination sink faucets shall have aerator tips. Reagent grade water faucets to have serrated hose ends. Faucets are to be swivel type except reagent grade water.

7. Vacuum Breakers: ASSE 1035 Integral vacuum breakers, shall be supplied on all domestic waterfixtures. The fume hood fixture shall have the vacuum breaker exposed no higher than 4 feet (2133.6mm) A.F.F.on face of hood (exposed vacuum breaker and piping to have same finish as other fixtures). The vacuum breaker for the eye wash fixture shall be located under the sink cabinet, visible when the cabinet doors are open.

8. Industrial Water Sign: 1/8 inch thick black laminated plastic with engraved white letters “INDUSTRIAL WATER DO NOT DRINK”. Provide a sign at all industrial hot and industrial cold water valves. At panel mounted valves mount sign on panel above valve handle and at all gooseneck fixtures provide with 3/8 inch thick split ring mounting bracket.

9. Service Identification. Index buttons mounted in fixture handles shall identify the followingservices. Buttons shall be color-coded and lettered.

	SERVICE	LETTERING	DISC COLOR
a.	Hot Water	HW	Red
b.	Cold Water	CW	Green
c.	Gas	Gas	Blue
d.	Air	Air	Orange
e.	Vacuum	Vac	Yellow
f.	Reagent Grade Water	RG	White
g.	Steam	STM	Black
h.	Nitrogen	N2	Brown
i.	Carbon Dioxide	CO2	Pink

10. Service Fixture Finish. Laboratory brass service fixtures shall be ground smooth, coated with satin chromium plated finish with a clear epoxy coating except where corrosion resistant finish is indicated. Fixtures shall receive multiple applications of coating and are baked for polymerization. Units must be assembled before coating and pressure tested before shipment.

11. Fixture Shipment. Fixtures shall be assembled in factory and supplied loose except for fume hood factory

mounted fixtures.

W. **ELECTRICAL SERVICE FITTINGS**

1. Service Fittings, General: Provide units complete with metal housings, receptacles, terminals, switches, pilot lights, device plates, accessories, and gaskets required for mounting on laboratorycasework.

2. Receptacles: Comply with NEMA WD 1, NEMA WD 6, FS W-C-596, and UL 498. Duplex type, Configuration 5 20R.

   a. Receptacle Grade: General grade, unless otherwise indicated.

   b. GFCI Receptacles: Comply with UL 943, Hospital grade.

3. Switches: Comply with FS W-C-896 and UL 20. Provide single-pole, double-pole, or 3-way switches as required; rated 120 to 277-V ac; and in amperage capacities to suit units served.

   a. Provide pilot lights adjacent to toggle switches where noted as "PL" next to switchidentification.

   b. Provide thermal-overload switches, single or double pole, as required, with maximumover current trip setting to suit particular motor controlled.

4. Pedestal-Type Fittings: Cast-aluminum housings with sloped single face or two faces, as indicated, with neoprene gasket under base and with concealed mounting holes in base for attaching to laboratory casework. Provide holes tapped for conduits.

5. Line-Type Fittings: Provide with cast-metal boxes with threaded holes for mounting on rigid steel conduit. Provide cover plates the same size as boxes.

6. Recessed-Type Fittings: Provide with galvanized steel boxes.

7. Finishes for Service-Fitting Components: Provide housings or boxes for pedestal- and line-type fittings with manufacturer's standard baked-on, chemical-resistant enamel in color as selected by Architect from manufacturer's full range.

   a. Color of Receptacles and Switches: As selected by Architect, unless otherwise indicatedor required by NFPA 70.

   b. Color of TVSS Receptacles: Blue.

8. Cover Plates: Provide satin finish, Type 304, stainless-steel cover plates with formed, beveled edges.

9. Cover-Plate Identification: Use 1/4-inch- (6-mm-) high letters, unless otherwise indicated. On stainless steel or chrome-plated metal, stamp or etch plate and fill in letters with black enamel. Provide on all cover plates.

Installation

X. **INSTALLATION OF CABINETS**

1. Install level, plumb, and true by means of the micro-adjustment device located in each bottom corner of the base cabinets. Where laboratory casework abuts other finished work, apply filler strips and scribe for accurate fit with no visible gaps, with fasteners concealed where practical.

2. Adjust laboratory casework and hardware so doors and drawers align and operate smoothly without warp or bind and contact points meet accurately. Lubricate operating hardware as recommended by manufacturer.

Y. **INSTALLATION OF COUNTERTOPS**

1. Abut top and edge surfaces in one true plane with flush hairline joints and with internal supports placed to prevent deflection. Locate joints only where shown on Shop Drawings.

2. Provide scribe moldings for closures at junctures of countertop, curb, and splash, with walls as recommended by manufacturer for materials involved. Match materials and finish to adjacent laboratory casework. Use chemical-resistant, permanently elastic sealing compound where recommended by manufacturer.

Z. **INSTALLATION OF SINKS**

1. Underside Installation of Epoxy Sinks: Use laboratory casework manufacturer's recommended adjustable support system for table- and cabinet-type installations. Set top edge of sink unit in sink and countertop manufacturers' recommended chemical-resistant sealing compound or adhesive and firmly secure to produce a tight and fully leak-proof joint. Adjust sink and securely support to prevent movement. Remove excess sealant while still wet and finish joint for neat appearance.

2. Drop-in Installation of Epoxy Sinks: Rout groove in countertop to receive sink rim if not prepared in shop. Set sink in adhesive and fill remainder of groove with sealant or adhesive. Use procedures and products recommended by sink and countertop manufacturers. Remove excess adhesive and sealant while still wet and finish joint for neat appearance.

12 50 00 - Furniture Selection

Revised 2019

Description

ASU procures most furniture utilizing the state purchasing contracts available to the University, in particular the Tri-University Furniture Purchasing contract. The ASU furniture buyer will assist the Design Professional (DP) in understanding the types of contracts available for use, and the furniture options and vendors that are on these contracts. For general furniture procurement, priority should be given to those manufacturers and vendors included on the Tri-University furniture purchasing contract. The DP will need to work closely with the Project Manager, Office of the University Architect (OUA) representative and the owner to select appropriate options.

For classrooms and instructional spaces, see the *Classroom Design and Technology Standards,* provided by the Office of the University Architect (OUA). This section applies to seating, computer workstations, 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 furniture needs of the project.

Capital Programs Management Group (CPMG) shall be provided a physical sample of each furniture item proposed for testing and approval. The DP will be responsible to obtain User Group and any other approvals as required on a project-by-project basis. When applicable, individual pieces of furniture for general purposes should be selected with the following considerations:

A. BIFMA Level Certification.

1. It is preferred that the furniture and furnishing products proposed are independently third- party certified as compliant with the ANSI/BIFMA e3 Furniture Sustainability Standard at level 1 or higher. Those products certified at level 1 or higher would receive preference over non-certified product.

2. Furniture and furnishings subject to level certification includes, but is not limited to, movable/full-height walls, systems furniture, desking systems, benching systems, case goods, storage cabinets, bookcases, file cabinets, desks, tables, screens, seating of all types, and related accessories.

B. GREENGUARD Indoor Air Quality rating and Certification Rating.

C. SMaRT Sustainability Certification.

D. Use of recycled or renewable materials and components.

E. Warranty.

12 52 00 - Seating

Revised 2022

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 International Building/Fire Codes, cost, durability, functional comfort, appearance/finish, and performance over time.

Refer to section 12 50 00 - Furniture Selection for overarching guidelines.

This standard for seating does not include classrooms, classroom auditoriums, or lecture halls. For classrooms, auditoriums or lecture hall standards, see the *Classroom Design and Technology Standards,* 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.

    a. A seat width of 17-20 inches suffices for most individuals and should be deep enough to permit the back to make contact with back portion of the chair and not create a pinch point at the knee bend.

  2. Type of Lumbar support in back.

    a. All seating shall have proper lumbar support.

    b. The back should be between 12-19 inches wide and should be easily adjustable both in angle and height by the user while seated.

  3. Versatility of seating.

    a. i.e. seat back height variable options, optional headrest for taller individuals, weight limit options, etc.

  4. Materials for seat and back.

    a. Seat padding level to allow for support and cushion.

  5. Arm and seat pan adjustment options.

  6. Option of casters and swivel function.

B. Appearance

  1. The appearance shall be coordinated with the interior of the space and consider the acoustical requirements for the space.

C. 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).

D. Cost

1. High quality seating shall be purchased to minimize the long term life cycle costs.

   a. Warranty should be considered in the life cycle cost analysis.

12 56 33 - Classroom Work surfaces

Revised 2022

A. For classrooms work surfaces standard, see the *Classroom Design and Technology Standards,* provided by the Office of the University Architect (OUA).

12 56 33.23 - Computer Workstations

Revised 2022

Description

Computer workstations shall be provided that will meet the demands of the equipment, plus the necessary space for student materials. See the *Classroom Design and Technology Standards,* provided by the Office of the University Architect (OUA) for more information on computer labs and classrooms for student use.

Design Standard

A. Allow for a minimum surface area of six and one quarter (6.25) square feet to be provided.

B. Design of monitor, keyboard, and mouse locations should consider user ergonomics and comfort.

C. Furniture selection for computer workstations shall have provisions for securing the equipment and furniture in the room.

D. Additional ventilation is required if white marker boards are utilized due to marker fumes.

E. Provisions for electrical fires should be considered for areas with computer workstations.

12 93 00 - Site and 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 section, they shall be submitted to the Office of the University Architect for review and approval at the completion of the schematic design phase.

To meet universal accessibility requirements, a minimum of one ADA table shall be provided for 5% of all seating designed in the project area. However, the provision of more accessible tables is encouraged.

If additional items are approved for a specific project, then Item/Vendor/Supplier information and Specifications (including description, size and color of items) shall be furnished to the Office of the University Architect for review and determination.

Design Standard

A. Mall Benches

1. Manufacturer: Landscape Forms

7800 E. Michigan Avenue, Kalamazoo, MI 49048
Model: Austin
Finish/Color: RAL 7042
Form: Freestanding Base, Backed with Center Arm

B. Tables

1. Manufacturer: Landscape Forms
7800 E. Michigan Avenue, Kalamazoo, MI 49048
Model: Catena Base, Marneaux® Top
Finish/Color: Base: RAL 7042, Top: Calgary
Form: No umbrella hole, Freestanding, Top 36” diameter, 36”x36” square

2. Manufacturer: Maglin Corporation
999 18th Street Suite, 3000 Denver, CO 80202
Model: FORO MMP-1700-00012
Finish/Color: Base, Top Frame: RAL 7042, Top Panel: Orange Peel HDPE, Grey
Form: 30” Square, Freestanding, M1 Pattern

3. Manufacturer: Maglin Corporation
999 18th Street, Suite 3000 Denver, CO 80202
Model: FORO MMP-1700-00017
Finish/Color: Base, Top Frame: RAL 7042, Top Panel: Orange Peel HDPE, Grey
Form: 30” x 54” ADA, Freestanding, M1 Pattern (5% of all new seating)

4. Manufacturer: Maglin Corporation
999 18th Street, Suite 3000 Denver, CO 80202
Model: Ancora ACTB2100-BH-S-FS
Finish/Color: Base, Top Frame: RAL 7042, Top: Orange Peel HDPE, Grey
Form: 8’0” Length, Bar Height

C. Chairs

1. Manufacturer: Landscape Forms
7800 E. Michigan Ave. Kalamazoo, MI 49048
Model: 21 Chair
Finish/Color: RAL 7042, with anodized back and seat slats
Form: Arms

2. Manufacturer: Maglin Corporation
999 18th Street, Suite 3000 Denver, CO 80202
Model: FORO MCH-1700-00001
Finish/Color: RAL 7042
Form: Steel Frame, Laser Formed Steel Seat with Aluminum Back Casting,
Laser Design 1

3. Manufacturer: Maglin Corporation
999 18th Street, Suite 3000 Denver, CO 80202
Model: FORO FRST1700-BH-MSF-M1
Finish/Color: RAL 7042
Form: Steel Frame, Steel Seat with Aluminum Back Casting, Laser Design 1, Bar Height

D. Specialty Furniture

1. Manufacturer: Landscape Forms
   7800 E. Michigan Ave. Kalamazoo, MI 49048
   Model: Other models as approved by The Office of The University Architect
   Finish/Color: As approved by The Office of The University Architect
   Form: Freestanding

2. Manufacturer: Loll Designs
   5912 Waseca Street Duluth, Minnesota 55807
   Model: Models as approved by The Office of The University Architect
   Finish/Color: Charcoal Grey, Leaf Green, Sunset Orange, Sky Blue
   Form: Varies per Design

3. Manufacturer: Maglin Corporation
   999 18th Street, Suite 3000 Denver, CO 80202
   Model: FLEXX Panels D-MMP-2600-00003-000-001
   Finish/Color: RAL 7042
   Form: With ASU Panel Design, Configuration Varies per Layout

4. Manufacturer: Maglin Corporation
   999 18th Street, Suite 3000 Denver, CO 80202
   Model: Urban Canopee Corolle MSH-3600-00001 thru 11
   Finish/Color: color will vary upon location
   Form: Configuration Varies per Layout

E. Signs

1. Refer to the ASU Signage and Environmental Guidelines in Section 2.

Bicycle and Skateboard Racks

All racks are owned and maintained by Parking & Transit Services (PTS)

2. Horizontal Bicycle Rack
   Manufacturer: Ground Control Systems
   2021 Arden Way, Sacramento, CA 95825
   Model: DV 215 Varsity
   Finish/Color: Powder coat – RAL 7042

3. Vertical Bicycle Rack
   Manufacturer: Dero
   504 Malcolm Avenue SE, Suite 100, Minneapolis, MN 55414
   Model: Ultra Space Saver Squared
   Finish/Color: Powder coat – RAL 7042
   Form: Single and/or Double Sided

4. Tiered Bicycle Rack
   Manufacturer: Dero
   504 Malcolm Avenue SE, Suite 100, Minneapolis, MN 55414
   Model: Dero Decker
   Finish/Color: Powder coat – RAL 7042
   Form: Single and/or Double Sided

5. Skateboard Rack
   Manufacturer: Ground Control Systems
   2021 Arden Way, Sacramento, CA 95825

Model: SM-10X
Finish/Color: DuraPlas® Silver
Form: Surface Mount

5. Surface Mount Hardware
Manufacturer: Bryce Fasteners
1230 N. Mondel Drive, Gilbert, AZ 85233
Model: Penta Nut #34GNP37

F. Area Lighting

1. Light Fixture
Manufacturer: Visionaire Lighting, LLC
19645 Rancho Way, Rancho Dominguez, CA 90220
Model: Premier II Series, Model PRE-2-L w/7 pin NEMA socket
Finish/Color: Powder Coat – RAL 7042
Form: Color Temperature – 4000K

2. Light Pole
Manufacturer: Hapco
26252 Hillman Highway, Abingdon, VA 24210
Model: RSA12B5-H-GC (Pedestrian), RSA18B5-H-GC (Area)
Finish/Color: Powder Coat – RAL 7042
Form: Height subject to photometric verification; Light poles with multiple applications (power/data/A.V.) are required to use segmented poles.

G. Specialty Lighting

Manufacturer: Landscape Forms
7800 E. Michigan Avenue, Kalamazoo, MI 49048
Model: Arne
Finish/Color: Powder coat, RAL 7042
Form: Fixture count, beam spread and pole height per design

H. Bollard Lighting

Manufacturer: KIM Lighting

Model: Pavilion
Finish/Color: Powder coat, RAL 7042
Form: Fixture count, beam spread and pole height per design

Parking Lot Lighting

Manufacturer: Landscape Forms
7800 E. Michigan Avenue, Kalamazoo, MI 49048
Model: Arne
Finish/Color: Powder coat, RAL 7042
Form: Fixture count, beam spread and pole height per design

I. Chairs

1. Manufacturer: Landscape Forms
7800 E. Michigan Ave. Kalamazoo, MI 49048
Model: 21 Chair
Finish/Color: Mercury

Form: Arms

2. Manufacturer: Maglin Corporation
999 18th Street, Suite 3000 Denver, CO 80202
Model: FORO MCH-1700-00001
Finish/Color: Silver 14
Form: Steel Frame, Laser Formed Steel Seat with Aluminum Back Casting,
Laser Design 1

3. Manufacturer: Maglin Corporation
999 18th Street, Suite 3000 Denver, CO 80202
Model: FORO FRST1700-BH-MSF-M1
Finish/Color: Silver 14
Form: Steel Frame, Steel Seat with Aluminum Back Casting, Laser Design 1, Bar Height

J. Specialty Furniture

1. Manufacturer: Landscape Forms
7800 E. Michigan Ave. Kalamazoo, MI 49048
Model: Other models as approved by The Office of The University Architect
Finish/Color: As approved by The Office of The University Architect
Form: Freestanding

2. Manufacturer: Loll Designs
5912 Waseca Street Duluth, Minnesota 55807
Model: Models as approved by The Office of The University Architect
Finish/Color: Charcoal Grey, Leaf Green, Sunset Orange, Sky Blue
Form: Varies per Design

3. Manufacturer: Maglin Corporation
999 18th Street, Suite 3000 Denver, CO 80202
Model: FLEXX Panels D-MMP-2600-00003-000-001
Finish/Color: Silver 14
Form: With ASU Panel Design, Configuration Varies per Layout

K. Signs

1. Refer to the ASU Signage and Environmental Guidelines in Section 2.

L. Bicycle and Skateboard Racks

All racks are owned and maintained by Parking & Transit Services (PTS)

1. Horizontal Bicycle Rack
Manufacturer: Ground Control Systems
2021 Arden Way, Sacramento, CA 95825
Model: DV 215 Varsity
Finish/Color: Powder coat – RAL 9007

2. Vertical Bicycle Rack
Manufacturer: Dero
504 Malcolm Avenue SE, Suite 100, Minneapolis, MN 55414
Model: Ultra Space Saver Squared
Finish/Color: Powder coat – RAL 9007
Form: Single and/or Double Sided

3. Tiered Bicycle Rack
   Manufacturer: Dero
   504 Malcolm Avenue SE, Suite 100, Minneapolis, MN 55414
   Model: Dero Decker
   Finish/Color: Powder coat – RAL 9007
   Form: Single and/or Double Sided

4. Skateboard Rack
   Manufacturer: Ground Control Systems
   2021 Arden Way, Sacramento, CA 95825
   Model: SM-10X
   Finish/Color: DuraPlas® Silver
   Form: Surface Mount

6. Surface Mount Hardware
   Manufacturer: Bryce Fasteners
   1230 N. Mondel Drive, Gilbert, AZ 85233
   Model: Penta Nut #34GNP37

M. Area Lighting

3. Light Fixture
   Manufacturer: Visionaire Lighting, LLC
   19645 Rancho Way, Rancho Dominguez, CA 90220
   Model: Premier II Series, Model PRE-2-L w/7 pin NEMA socket
   Finish/Color: Powder Coat – RAL 9007
   Form: Color Temperature – 4000K

4. Light Pole
   Manufacturer: Hapco
   26252 Hillman Highway, Abingdon, VA 24210
   Model: RSA12B5-H-GC (Pedestrian), RSA18B5-H-GC (Area)
   Finish/Color: Powder Coat – RAL 9007
   Form: Height subject to photometric verification; Light poles with multiple applications are required to use segmented poles (power/data/A.V.)

N. Specialty Lighting

Manufacturer: Landscape Forms
7800 E. Michigan Avenue, Kalamazoo, MI 49048
Model: Arne
Finish/Color: Powder coat, Silver (SIL)
Form: Fixture count, beam spread and pole height per design

12 93 23 - Trash and Litter Receptacles

Description

This section applies to all recycling, trash and collection receptacles exterior to the main confines of a building. Receptacles shall conform to the standards of this section, and where additional items are proposed but not included in this section, they shall be submitted to the Zero Waste (ZW) Program in ASU Facilities Development and Management (FDM) for review and approval at the completion of the schematic design phase.

If additional items are approved for a specific project, Item/Vendor/Supplier information and Specifications (including description, size and color of items) shall be furnished to (ZW) for review and determination.

Design Standard

A. Compactors

Quantity: Minimum 2 Required at Each Site – 1 Landfill, 1 Recycling and accommodation for organics collection
Type: Self-Contained
Doghouse: Site Specific
Doors: Metal, Double, Magnetic Latch
Charge Box Capacity: 2 to 4 Yards
Color: Recycle - Blue, Trash - Beige, Organics - Green
Pressure gauge: Color-Coded
Rear Box Capacity: 15 to 34 Yards
Rear Box Type: Wet Trash/Dry Recycling/Wet Organics
Power: Spotted Solar with 3 Phase, 10H, 480 Volt
Cycle: Multi
Roller Plates: Required
Guide Rail: 15 Foot with Stops
Install: Yes
Manufacture Local: Closest Possible
PC/R Content: Highest Possible
Odor Control: Sonozaire™ Odor Neutralizer – Trash
Monitoring System: Capable

B. Recycling/Trash Receptacles

1. OUTDOOR

a. Multi Purpose Litter

Manufacturer: Landscape Forms
Model: Custom Litter/Recycle/Compost Combination
Finish/Color: Recycle – Blue RAL 5012, Landfill – Silver RAL 7042, Compost – Green RAL 6018
Signage: Stainless graphic panel for illustrative copy along back edge, custom top edge copy per side
Size: 35 Gallon Liners for the interior cavity in each bin
Location: Outdoor Public Space Collection
Quantity: Consult with ASU Zero Waste Program

b. Residential Hall Donation Bin

Manufacturer: Big Brothers Big Sisters
Finish/color: White
Size: 3.5 Yard Cubic Volume (i) 42”D x 50”W x 68”H
Location: Outdoor at Residence Halls
Quantity: Consult with ASU Zero Waste Program

2. INDOOR

a. Transit Receptacle

Manufacturer: Forms and Surfaces
Color: Stainless Steel with Finish Options
Size 60 Gallon/20 Gallon (14-3/8”L x 10-1/4”W x 35.9”H)
Location: Indoor – High Profile Public Collection, Executive Hallways, Lobbies
Quantity: Specific to Occupant – Consult with ASU Zero Waste Program

b. **Office Recycling Container**

Manufacturer:	Rubbermaid
Color:	Blue
Size:	7 Gallon
(i)	14-3/8"L x 10-1/4"W x 15"H
Location:	Indoor – Cubicle, Office or Small Meeting Room
Quantity:	1 per Room or Cubicle

c. **Cardboard and Styrofoam Collection Bin**

Manufacturer:	Tri-C Club Supply
Color:	Royal Blue
Size:	12 Bushel (36"L x 26"W x 27.5"D)
Location:	Indoor – centralized collection of cardboard and Styrofoam
Quantity:	Consult with ASU Zero Waste Program

d. **Special Collection Bin**

Manufacturer:	Max-R or Equal
Color:	Varies (consult with ASU Zero Waste Program)
Size/Type:	3 stream (26"W x 21"D x 46"H)
Location:	Indoor – centralized collection of non-commingled recycling
Quantity:	Consult with ASU Zero Waste Program

e. **Vented Slim Jim Container**

Manufacturer:	Rubbermaid
Color:	Blue
Size:	23 gallon (22"L x 11"W x 30"H)
Location:	Indoor – centralized collection in office, classroom, kitchen, hallway, copy room, some public spaces
Quantity:	Consult with ASU Zero Waste Program

DIVISION 13 - SPECIAL CONSTRUCTION

13 03 00 - Wellness Rooms

Description

Access to appropriate space for lactation for mothers on the ASU campus is essential and required by the 2010 amendment to the Fair Labor Standards Act. As a resource to students, staff, and campus visitors, Arizona State University is committed to designating and maintaining a minimum of one wellness room in as many of its buildings as is reasonably feasible.

Uses:

A wellness room (WR) should be adequately equipped for lactation purposes as the primary user (registration with ASU Student and Family Resources Office recommended), but could also be utilized for health-related interventions such as insulin injections, administration of medication, or health evaluations. The rooms use for short periods of meditation or relaxation are also appropriate.

Design Standard

A. New Rooms:

Each building construction project should be evaluated during the programming phase to outline the scope of compliance that can be achieved. The WR should meet accessibility guidelines for all features of the room. Following the design guidelines outlined here will yield a WR that offers comfort and respect to intended users.

A. Locations:

1. New Buildings - A minimum of one wellness room (WR) should be provided in each new building.
2. Building Expansions - Major building expansions should include a WR unless it is determined that the existing facility has a WR that can be accessed from the building expansion or can be converted into a WR as part of the project scope.
3. Renovations - Renovation projects are defined as those projects involving the alteration of a portion of an existing building. Renovations range from simple aesthetic improvements to complex physical reconfigurations and systems' replacement. In general, for minor renovations or room specific renovations, requirements for a WR will not be part of the project scope. For projects where major renovations are part of the scope, inclusion of one WR, if not already existing, should be included. For major renovation projects affecting entire floors or buildings, a WR should be provided if reasonably feasible.

B. Criteria:

1. Room Requirements (to accommodate lactating mothers)
2. Location – The WR shall be conveniently located within the building, near stairs, elevators, and/or restrooms, in a safe area accessible to all.
3. Size – Provide a minimum footprint of 7 feet by 7 feet as it will allow for a 5-foot accessible turning diameter. See example shown. Other configurations may be acceptable as well.
4. Table/Counter - Provide a minimum 24-inch deep by 30-inch wide, ADA compliant, plastic laminate or solid work surface for the pump and bottles to rest on in front of the task chair. Provide above counter outlets at the work area. Provide telecommunication outlets within easy reach of the work area.
5. Sink - Provide a sink and faucet (goose neck or kitchen type) combination deep enough to wash bottles and pump parts. Locate the sink adjacent to the work area. Indicate location for University provided soap and paper towel dispensers.
6. Sound Privacy – Room walls should extend up to the floor above and be insulated to minimize sound transmission into adjacent spaces. Install fabric panels, curtains, carpeting, or other sound-dampening materials in the room to aide in reducing sound transmission.
7. Lighting - Task lighting should be provided over the sink and the work area. Provide overhead lighting for the room.
8. Power- Provide one electrical duplex with USB ports and one data above the counter. Provide other electrical duplex locations as required by code.
9. Door Privacy - Install a user-operated indicator deadbolt for privacy that will display an "Occupied" message to discourage interruptions.
10. Signage – The WR should be signed as "Wellness Room" and should include the International symbol for Breastfeeding.
11. Chair - Provide a task chair suitable for a workstation with seat, back, armrest, lumbar, tension, and height adjustments. The chair shall have casters to allow the user freedom of movement when hands are occupied with bottles of milk and pump parts. An alternative chair type could be a durable, reclining chair to accommodate meditation or relaxation.
12. Accessories - Provide a trash can, compostable wet wipes for cleaning, a paper towel dispenser, a coat rack or coat hooks, a counter mirror at the sink, a magazine rack, a clock, and a bulletin board. As many mothers may be sharing the room, provide room scheduler outside the door to help schedule room use.

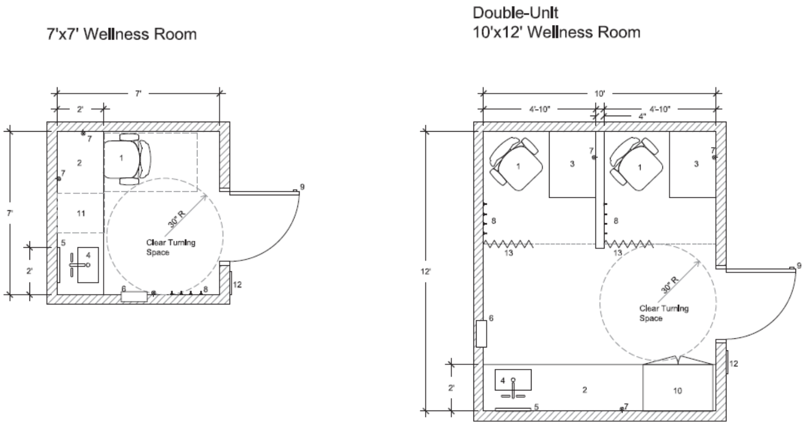
13. HVAC – Optional: Provide a timed thermostat in the room for user control and thermal comfort so that the room temperature can be maintained year-round at a comfortable level such as in a dressing room.
14. Milk Storage – Optional: Provide a midsize or compact refrigerator for milk storage.

C. B. Existing Rooms

For existing Wellness Rooms or rooms temporarily designated as such, the following design guidelines shall be utilized so the room can be used for lactation and/or pumping purposes. Buildings without fully equipped Wellness Rooms should look for opportunities to add one when possible.

Criteria:

1. Size – Provide a minimum footprint of 7 feet by 7 feet as it will allow for a 5-foot accessible turning diameter. See example shown. Other configurations may be acceptable as well.
2. Table/Counter - Provide a minimum 24-inch deep by 30-inch wide, ADA Compliant, plastic laminate or solid work surface for the pump and bottles to rest on in front of the task chair. Provide above counter outlets at the work area. Provide telecommunication outlets within easy reach of the work area.
3. Sound Privacy – If possible, the room should provide sound isolation from adjoining rooms and/or hallways. Install fabric panels, curtains, carpeting, or other sound-dampening materials in the room to aide in reducing sound transmission.
4. Lighting – Existing lighting should be sufficient for execution of table-height activities. Task lighting should be provided if needed.
5. Power- Room should have a minimum of one easily accessible electrical duplex (within 2 feet of stationary table or counter) and for use with electrical pumping supplies. Receptacle shall be served by a dedicated circuit.
6. Door Privacy - Install a user-operated indicator deadbolt for privacy that will display an “Occupied” message to discourage interruptions.
7. Chair - Provide a task chair suitable for a workstation with seat, back, armrest, lumbar, tension, and height adjustments. The chair shall have casters to allow the user freedom of movement when hands are occupied with bottles of milk and pump parts. An alternative chair type could be a durable, reclining chair to accommodate meditation or relaxation.
8. Accessories - Provide a trash can and sustainable compostable wet wipes for cleanup.



7'x7' Wellness Room

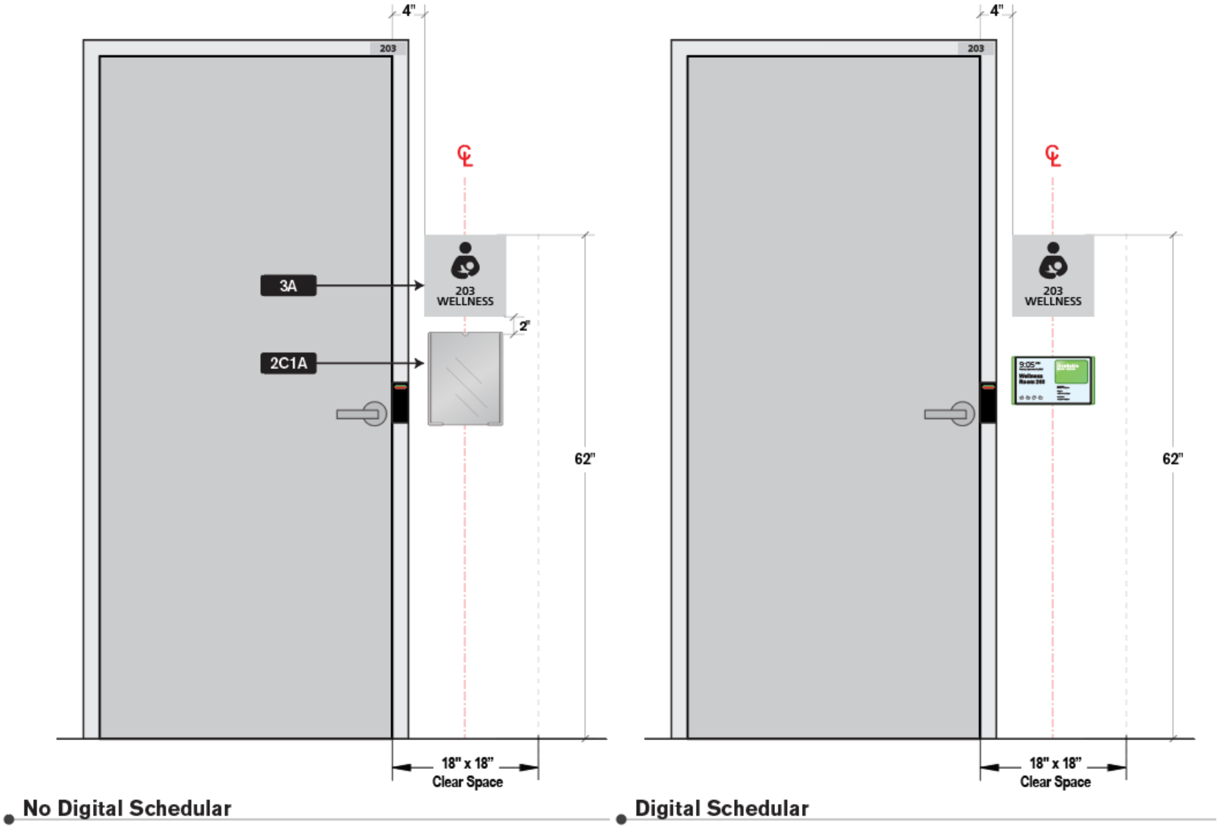
Double-Unit
10'x12' Wellness Room

1. Chair
2. Counter
3. Table or Work Surface for Pump
4. Sink with Cold and Hot Water
5. Mirror
6. Paper Towel Dispenser recessed In-wall If possible
7. Electrical Outlet (above the counter)
8. Coat Hooks
9. Door with Privacy Indicator- Occupied / Unoccupied
10. Cabinet for Storage or Under-Counter Storage Pedestal
11. Under-Counter Storage Pedestal
12. Room Signage
13. Privacy Screen

Figure 13-03-00.7.01 – Signage Location at Wellness Rooms

9. **Signage** – The WR should be signed “Wellness” along with the assigned room number and international symbol for Breastfeeding. For rooms without digital schedulers, a standalone literature holder must be included 2” below the Room ID sign to accommodate a paper schedule insert.

10. Signage – The WR should be signed as “Wellness Room” and should include the International symbol for Breastfeeding.



No Digital Schedular

Digital Schedular

Figure 13-03-00.7.01 – Signage Location at Wellness Rooms

13 04 00 Fall Protection

Description:

This section addresses fall protection for roofs, ladders and other areas that are used by employees and contractors. Fall protection must protect occupants that may be exposed to fall hazards and will meet OSHA standards 1910.29, 1926.502, 1910.28, 1926.501,and code requirements.

Design Standard:

A. New construction and roof renovation for ASU buildings shall use parapet walls and passive fall protection such as railings and must be at least 39" high from the walking surface and meet OSHA requirements. If parapet walls are not going to be at least 39", then safety railings must be installed and meet OSHA standards.

B. Anchor points and warning lines must meet OSHA requirements. Must be located at least 6 feet away from the roof edge where the parapet wall is less than 39".

C. New and existing ASU buildings that have roof access hatches shall have guardrails around the hatch and the door shall swing away from the roof access hatch.

D. Any continuous fixed ladders over 24 feet must be equipped with a personal fall arrest system or ladder safety system installed for fall protection. Cages around fixed ladders are no longer an accepted form of fall protection.

E. Employee access points to equipment must be designed so that employees or v do not come within 6 feet of the roofs edge.

F. Skylights must have glass that is rated by the manufacturer or signed by the architect that it is rated for fall protection. If the glass is not rated for fall protection, then railings shall be placed around the skylight.

G. The DP shall submit design options along with material colors and samples to the Office of the University Architect for approval.

13 12 00 - Fountains and Water Features

Description

This section addresses features in, or around, a project that utilizes water as a 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 Arizona State University and the State of Arizona.

Design Standard

Not acceptable on campus unless specific approval is obtained by the Office of the University Architect (OUA).

DIVISION 14 - CONVEYING EQUIPMENT

h14 20 00 - Elevators

Description

A. This section applies to the design and installation of passenger elevators.

1. There shall be a minimum of two (2) elevators for any building over one story, regardless of floor area or building type. This will ensure continuous service to the building when one unit is out of service for repairs or when undergoing PM. One elevator shall be provided with a class C3 loading/platform.
2. In designing multi-elevatored buildings, at least one car shall also be designed for occasional use as a true freight elevator with vertical bi-parting doors. Platform shall be designed in one of the three types of class C loading based on building needs.
3. The Design Professional (DP) shall supply, prior to the completion of the schematic design phase, a signed traffic analysis from a certified elevator supplier or a recognized elevator consultant company indicating the number of recommended elevators, types and speeds, for the project. This Information shall be submitted to the elevator manager for review and approval.
4. Proprietary control equipment will not be acceptable. Electronic controls will require that all manuals, control diagrams, adjusting and operating information shall be supplied, along with "The Adjusters Tool" with password instructions and codes, to the Owner.
5. The tool, manuals, control diagrams, and instruction manual shall become the property of ASU. The adjuster’s tool shall allow the current elevator maintenance contractor to make complete adjustments to all areas of the elevator. Electronic copy of Elevator manual, Instruction manual and wiring diagrams shall be included in close out package and submitted to the elevator manager..
6. All PC boards and components shall be available to the Elevator Contractor holding the Owner’s elevator maintenance service contract. 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.
7. All controls shall 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 Manager. Controllers shall be provided with security provisions, load weighing and remote monitoring.
8. All Americans with Disabilities Act (ADA) handicap standards will be observed in design and installation using the most current adopted codes: ADAAG, ANSI A117.1, UFSA NE Handicap standards and ASME A17.1 will be met or exceeded.
9. Electronic Door edges will be provided on all elevators using 150 or more microprocessor controlled infra-red light beams. Door edge shall be designed and provided by Janus Panachrome, Smart 3d, with voice and proximity detection. All others shall be approved by ASU Elevator Manager. Detector shall comply with ASME- A17.1 2019 edition and or latest adopted code by the state.
10. Cab lighting shall be on emergency power or secondary power supply at ASU at the Tempe campus (battery backup will not be accepted). At the Polytechnic, ASU Downtown, or West campus, where no centralized emergency power is available, cab lighting by battery backup will be accepted if a building generator is not available.
11. At least one elevator will be connected to emergency power through an automatic transfer switch. Elevators will be connected to normal building power for normal operation. If normal

power source is lost, elevators will be automatically transferred to campus emergency power. Where there is more than one elevator in a building and the emergency power source is capable of running only one elevator at a time, an elevator manual selection switch shall be provided. The fixture shall utilize an AZFS key switch. If the building does not have an emergency backup power source or it is not capable of carrying the load, a Battery Powered Lowering device, MCE TAP's unit or equivalent, shall be provided and connected.

12. Cab lighting will be recessed or indirect fluorescent lighting or LED's with low current demand ONLY. (Incandescent, fluorescent or halogens shall not be used).
13. An automatic light and fan shutdown control system shall be installed that will evaluate the system activity and automatically turn off the cab lighting and ventilation fan during periods of inactivity. The settings shall be field programmable.
14. Traveling Cables: Minimum of two (2) cables shall be provided with flame- and moisture-resistant outer cover. Prevent traveling cable from rubbing or chafing against hoistway or equipment with hoistway. Traveling cables shall be properly hung from the core as specified by the manufacturer, while supporting the outer cover with the use of split rod kellems grips. Beam pads to be provided as needed to prevent damage to the traveling cables. Provide (6) six paired shielded wires, (1) one Fiber Optic and (4) four stranded 18-gauge for card reader. Provide (1) one RG-6/U coaxial CCTV cables within traveling cable from car controller to car top, plus 3'-0" excess loop at both ends.
15. Conductors and Connections: Copper throughout with individual wires coded and connections on identified studs or terminal blocks. Use no splices or similar connections in wiring except at terminal blocks, control compartments, or junction boxes. Provide 50 percent spare conductors throughout. Run spare wires from car connection points to individual elevator controllers in the machine room. Provide (4) four pairs of spare 18-gauge shielded communication wires in addition to those required to connect specified items. Tag spares in machine room.
16. Conduit: Painted or galvanized steel conduit, EMT, or duct. Conduit size, ½" minimum. Flexible heavy-duty service cord may be used between fixed car wiring and car door switches for door protective devices.
17. The elevator pit light shall be provided with an LED fixture in NEMA 4-rated enclosure when in wet locations and shall not have less than 10 fc of illumination at the pit floor.
18. Warranty: To repair, restore or replace defects in elevator work materials and workmanship not due to ordinary wear and tear or improper use or care for 24 months from the date of completion of final elevator.
19. Furnish maintenance and call back service for a period of 24 months. Provide for each elevator 24/7 service from date of completion of final elevator during normal working hours, after hours, holidays and weekends. Response time for call back and entrapments shall be one hour.
20. Service shall consist of periodic examination of the equipment, adjustment, lubrication, cleaning, supplies and parts to keep the elevators in proper operation. Annual testing of elevators as required by A17.1 shall also be provided by the contractor.
21. Prior to completion of elevators, the Contractor shall notify and schedule a new installation and audit Inspection with the ASU elevator manager. Any deficiency noted by the elevator manager shall be rectified by the Contractor. PM to sign off on project only after acceptance by elevator manager.

Design Standard

A. General

1. Power supply to be 480Y/277 V (if available), 3 phase/60 cycle, 4-wire grounded system with soft starters.

2. Main elevator power disconnects will be rated for 125% of the FLA continuous duty minimum, and shall not be derated.
3. A Phase I and Phase II fire service recall system shall be provided for all elevators.
4. Where fire sprinklers are installed in elevator shafts or machine rooms, a shunt trip breaker will be installed to disconnect 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.
5. Any special fire protection systems (detection or suppression) for elevators must be connected to the building fire alarm systems that reports to ASU Dispatch.
6. All elevator fire recall switches shall be operated by the Arizona State AZFS Key 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.
7. 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 at the local building fire alarm panel.
8. The audible and visuals must be designed so that they can be disabled without affecting any other special functions.
9. 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.
10. On geared machines, provisions shall be made to manually bring car to floor level and open the car doors in case of complete power failure.
11. Machinery spaces shall be located to minimize vibration and noise, and be fully sound attenuated.
12. All wires in the travelling cables shall be terminated on a terminal board with permanent identification matching that used in schematic diagrams.
13. All relays, switches, resistors, overload devices, fuses, timers, etc., mechanically or electrically operated, shall be permanently marked with identification matching the shop drawings.
14. 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.
15. Temperature rise in windings shall not exceed 50°C above ambient in all testing modes.
16. All machinery rooms, where mechanical and electrical equipment is located, shall have a separate and independent air conditioning system installed. Air conditioning equipment shall be designed for a 72 degree indoor temperature. Machinery rooms shall maintain 75 degrees in the cooling mode. The AC units shall be provided with remote temperature monitoring which will report back to Central plant if temperature falls below set threshold.
17. Freight or service doors shall be electrically power operated to open and close.
18. No voice-recorded messages on the elevator phone will be allowed. All calls shall be sent with auto dial directly to ASU Police Services Dispatch. In addition to the normal means of communication, a second means of communication shall be provided when the elevator rise is 60’ or more. The two-way communication (where 60’ of elevator rise) shall be accessible within the building to emergency personnel.
19. Elevators shall be provided with Phone line monitoring system as per ASME A17.1 section

2.27.1.1.6. Elevators shall be provided with audio, text to talk and visual communication as required by the latest applicable code. Communication shall be as manufactured by Rath communication. No Substitute is allowed.

20. All elevators shall have a separate phone and data landline.
21. All elevator controllers shall have a network board for remote monitoring.
22. Provide a CAT6 connection for remote monitoring in each elevator equipment room at the controller.
23. Floor-to-ceiling car operating swing-return panels (COP's) shall have added bracing support in the middle of the panel to prevent deflection when buttons are pushed.
24. Car door Operator: High speed, heavy-duty door operator capable of opening doors at no less than 2-½ f.ps. Accomplish eversal in no more than 2-½" of door movement. Provide solid-state door control with closed-loop circuitry to constantly monitor and automatically adjust door operation based ujpon velocity, position, and motor current. Maintain consistent, smooth, and quiet door operation at all floors regarding of doo weight or varying air pressure. Acceptable closed=loop door operators: G.A.L. MOVFR
25. Machine-room-less elevators (MRL's) must have a 25-year life expectancy or end-of-life rated for 25+years, and free elevator belts every 5-years for 25-years. MRL shall be provided with traction steel suspension system only. All others shall be approved by Elevator Manager.
26. Machine-room-less elevators (MRL's) shall be provided with independent air conditioning. One for the control space, and one for the machine space. The machine space AC unit shall not be installed in the elevator hoistway. Cooling shall be accomplished by ducting the AC into the shaft. Thermostat for each location shall be provided and shall be located near the elevator controller in the control space and near the hoist machine in the machine space.
27. One elevator must comply with International Building Code (IBC) Chapter 30 Section 3002.4 requiring one elevator to accommodate an ambulance stretcher 24" x 84". Star of life identification plates shall also be provided on the entrance jambs.

B. Hydraulic

1. Hydraulic elevators shall be single-stage, direct center piston type, limited to a maximum of three (3) stories; 3,500 lbs. minimum capacity; 200 fpm minimum speed.
2. HMRL if provided shall be non-proprietary type and approved by Elevator Manager.
3. Car shall be fully accessible to persons with disabilities.
4. Machine room shall be located adjacent to first car stop if possible.
5. No underground hydraulic lines will be accepted.
6. Oil Hydraulic Silencer: An oil hydraulic silencer (muffler device) shall be installed at the power unit location. The silencer shall contain pulsation-absorbing material inserted in a blowout proof housing arranged for inspecting interior parts without removing unit from oil line.
7. For protection against chemical soil action or corrosion, wrap jack with spiral wrapping of specified tape. Wrap portion of jack unit beneath ground level, just prior to setting. Apply wrapping to provide double coverage.
8. The jack system will be supplied with schedule 40 PVC or steel sleeve protection system to prevent ground corrosion of the casing.
9. Environmentally-safe hydraulic fluid shall be utilized.
10. Submersible or Dry Pump Unit: Assembled unit consisting of positive displacement pump, induction motor, master-type control valves combining safety features, holding, direction, bypass, stopping, manual lowering functions, shut off valve, oil reservoir with protected vent

opening, oil level gauge, outlet strainer, drip pan, muffler, all mounted on isolating pads. Provide oil cooling unit and oil temperature thermostat to maintain oil at operating temperature. Enclose entire unit with removable sheet steel panels lined with sound-absorbing material. Provide SCR soft start with closed transition.

11. Oil Cooler: Provide new Oil-to-Air heat exchangers specifically designed to stabilize the oil temperature. Unit shall be a single self-contained unit utilizing high efficiency plates and fin style heat exchanger directly coupled with an internal oil pump to provide adequate circulation of the oil. Provide an electrical controller designed specifically for the cooling system. Provide an external thermostatically control to monitor the oil temperature and provide cooling on demand.

12. Provide a solid-state motor starter to provide current limit starting, motor protection and fault detection.

    Starter shall house the logic board, power switches, heat sinks, and current transformers in one integral assembly. Units rated 160 amps and below shall have adequate heatsinking to cool the power semiconductors based upon natural convection alone. Fans are not acceptable for starters of 160 amps and below. Set-up adjustments must be located on the front cover of the controller. Adjustments shall be made via keypad and LCD display. SCR modules, snubber circuit board, and logic circuit board are to be removable as one-piece assemblies. One logic assembly shall work in any size unit of any given line voltage range and current range.

Starter shall be rated as follows:

a. Starts/ hour: As required by Controller/Motor Manufacturer specifications

b. Duty Cycle: 30% duty cycle at 140% of units rated FLA

c. Start Profile: .75 Seconds @ 450% of units rated FLAd. Starter must be capable of running continuously at this rate in a 50Â°C ambient temperature without being shut down by thermal protective devices. Provide two contacts, (1) one Normally Open and (1) one normally closed, shall be provided to signal the status of the starter and control the fault contactor. Both must be internal to the starter. Starter shall automatically detect if it is connected inside the Delta, in Line, or if it is improperly connected to the motor. Motor configuration should be checked by starter upon power up. Starter shall be configured to operate in conjunction with a fault contactor to prevent motor damage in the event of a shorted S.C.R.

C. Traction

1. Traction elevators (with variable speed drive) shall be used for buildings four (4) floors or more; 5,000 lbs minimum capacity; 250 fpm minimum speed; microprocessor controlled.

2. Elevator Car shall comply with all Accessibility Compliance Standards

3. Hoistway doors shall be fully powered, especially if designed for freight usage in which the door openings shall be a minimum of 54 inches wide.

4. Traction elevators shall have load-weighing devices.

5. Geared or gearless machine shall be of an AC type design. Acceptable machines shall be

   Hollister Whitney, or hImperial. All others shall be approved by Elevator manager.

6. Emergency Brake:

   Provide means to prevent ascending car over-speed and unintended car movement per code. Acceptable emergency brake devices:

d. Hollister-Whitney

e. Imperial

f. Provide integral secondary machine mounted emergency brake as designed by approved machine manufacturers.

g. Provide control circuits to enable the device to function as required by Code.

7. Solid State Power Conversion and Regulation Unit:

a. Provide solid state, alternating current, variable voltage, variable frequency (ACV^{3}F), I.G.B.T.converter/inverter drives.

b. Design unit to limit current, suppress noise, and prevent transient voltage feedback into building power supply. Provide internal heat sink cooling fans for the power drive portion of the converter panels. Conform to IEEE standards 519-2022 for line harmonics and switching noise.

c. Isolate unit to minimize noise and vibration transmission. Provide isolation transformers, filter networks, and choke inductors.

d. Suppress solid-state converter noises, radio frequency interference, and eliminate regenerative transients induced into the mainline feeders or the building standby power generator.

e. Supplemental direct-current power for the operation of hoist machine brake, door operator, dispatch processor, signal fixtures, etc., from separate static power supply.

f. ACV3F Drives for gearless elevators shall be regenerative and utilize IGBT converter/inverter and dynamic braking during overhauling condition.

g. Encoder: Direct drive, solid-state, digital type. Update car position at each floor and automatically restore after power loss.

14 27 00 - Passenger Cabs – Interior and Fixtures

Description

This section applies to the interior furnishing and finish of all passenger elevator cabs, regardless of whether they are hydraulic or traction type.

Design Standard

A. Floor identification numbers shall include braille adjacent to control buttons and within reach range per Americans with Disabilities Act (ADA) standards.

B. On elevators exposed to exterior environment, all fixtures shall be NEMA 4X rated water/ corrosion resistant. Fixtures shall be manufactured by CJ Anderson or equal.

C. Car and hall buttons to be illuminated tamper/vandal-proof devices.

D. Car position indicator (PI) shall be LED’s with travel signaled by lantern and gong.

E. Lighting and signals shall be tamper/vandal resistant buttons with center jewels which illuminate to indicate that a call has been registered at the floor for the indicated direction -proof for both the cab COP and hall call stations.

F. Hall Position Indicator: A vandal type position indicator shall be provided and mounted for optimum viewing. As the car travels, its position in the hoistway shall be indicated by the illumination of the alphanumeric character corresponding to the landing which the elevator is stopped or passing. When hall lanterns are provided, the position indicator shall be combined with the hall lanterns in the same faceplate. Faceplates shall match hall stations. Provide at all landings.

G. Hall lanterns: A vandal type hall lantern with adjustable chime shall be provided at each landing and located adjacent to the entrance. When illuminated, the lanterns shall indicate the elevator car that shall stop at the landing and in what direction the car is set to travel. When the car reaches a predetermined distance from the floor where it is going to stop, the corresponding hall lantern shall illuminate and the chime will sound. The hall lantern shall remain illuminated until the car doors close in preparation for leaving the floor. Illumination of the arrow shall be with LED's. Faceplates shall match the hall station finish. Provide at all landings.

H. Each car shall have a tamper-proof auto dialing telephone, reporting to ASU Police Services Dispatch. The Car station shall be provided with fan, lighting, independent service, access enable, emergency light test button and stop key switches located behind a closed cabinet. Ten (10) sets of each type of key shall be provided in close-out package.

I. Walls shall be plastic laminate of a color that facilitates easy maintenance or #4 brush-finished Stainless Steel.

J. Car and hoistway sills shall be made of Nickel material.

K. The interior door front and transom shall be finished with #4 stainless steel with front return and swing panel.

L. The exterior surface of doors (room side) and entrance frames shall be finished with #4 stainless steel returns and trim.

M. Ceilings shall be suspended, tamper/vandal resistant; lighting shall be fluorescent fixtures or LED's supplying an average car lighting level of 30-foot candles. Ceiling shall be provided with solid grid panels. Flexible translucent ceiling panels will not be accepted.

N. Floors shall be hard surfaced (rubber, tile, VCT, or equivalent etc.). Hard rubber flooring is to be Roppe or FLEXCO hard rubber tiles, 22-1/2 inch by 22-1/2 inch.

O. Finish surfaces shall be demountable or fitted with brackets or holders to secure a protective blanket that shall protect surface(s) when on- and off-loading material. Blanket buttons shall be permanently mounted to panel walls.

P. All elevator cabs shall be supplied with an appropriate number of protective blankets for each elevator. The blankets shall be stored in the elevator equipment room when not in use.

Q. Each cab shall be supplied with three (3) side continuous stainless steel handrail, #4 finish mounted with set screws to pins for easy removal; emergency lighting and two-speed exhaust fan.

R. Elevator pit shall have a sump pump flush mounted in the pit. The sump pump shall be capable of pumping 50 gallons per minute for each elevator sharing a common shaft. 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.

S. For hydraulic elevators, provide a holding tank large enough to hold 125% of capacity of the hydraulic tank or an oil separator capable of handling the hydraulic capacity of the system.

T. Car Operating Panel

1. Car operating panel without faceplate consisting of a metal box containing vandal resistant operating fixtures, mounted behind car swing return panel. Swing panel shall be hinged and constructed of Stainless Steel.
2. Suitably identify floor buttons, alarm button, door open button, door close button and emergency push-to-call button with SCS Elevator Products, Inc. or Visionmark cast tactile symbols rear mounted. Configure plates per local building code accessibility standards including Braille. Locate operating controls no higher than 48" above the car floor; no lower than 35" for emergency push-to-call button and alarm button.
3. Provide minimum 3/4" diameter raised or flush floor pushbuttons with LED illumination to indicate call registration.
4. Provide alarm button to ring bell located on car, illuminate button when actuated.
5. Provide keyed stop switch at bottom of car operating panel in locked car service compartment. Arrange switch to sound main control panel distress signal when actuated.

Mark device to indicate “run” and “stop” positions.

6. Provide “door open” button to stop and reopen doors or hold doors in open position.
7. Provide “door close” button to activate door close cycle. Cycle shall not begin until normal door dwell time for a car or hall call has expired, except firefighters’ operation.
8. Provide a filler plate to match proximity cutout size in applied car panel which shall match in finish, including direction of graining, where proximity reader cutout is not initially utilized.
9. Provide Firefighters' locked service compartment with recessed flush door as required by code. Door material and finish shall match car return panel or car operating panel faceplate. Locate illuminated fire hat and audible signal directly above locked cabinet door.
    a. Provide Firefighters’ Phase II key switch with engraved instructions filled red.
    b. Door Open Button
    c. Door Close Button
    d. Call Cancel Button
    e. Firefighters’ Phone Jack
10. Provide lockable service compartment with recessed flush door. Door material and finish shall match car return panel or car operating panel faceplate. Include the following controls in lockable service cabinet with function and operating positions identified by permanent signage or engraved legend:
    a. Inspection switch.
    b. Light switch.
    c. Three Speed Blower, Four-position exhaust blower switch.
    d. Independent service switch and inspection switch
    e. Constant pressure test button for battery pack emergency lighting.
    f. 120-volt, AC, GFCI protected electrical convenience outlet.
    g. Card reader override switch.
    h. Stop switch.
    i. Switch to select either floor voice annunciation, floor passing tone, or chime.
    j. Car lighting dimmer switch.
11. Provide black paint filled (except as noted), engraved, or approved etched signage as follows with approved size and font:
    a. Phase II firefighters’ operating instructions on inside of Firefighters’ service compartment door filled red.
    b. “FIRE SERVICE” on the face of the Firefighter’s service compartment door filled red.
    c. Car number on main car operating panel.
    d. “No Smoking” on main car operating panel.
    e. Car capacity in pounds on service compartment door.
    f. Engrave “Elevator No. xxx” and state number on car station.
    g. Engrave “Elevator Certificates located in Facilities Management Office”

U. Car Top Control Station: Provide new top of Car Inspection Station. Mount to provide safe access and utilization while standing in an upright position on car top. Mount within 35” from the sill line where Feasible otherwise provide secondary top car stop switch accessible from the landing sill.

V. Work Light and Duplex Plug Receptacle: GFCI protected outlet at top and bottom of car. Include On/off switch and lamp guard.

W. Communication System:

a. “Push to Call,” two-way communication instrument in car with automatic dialing, tracking, and recall features with shielded wiring to car controller in machine room. Provide dialer with Automatic rollover capability with minimum two numbers, as manufactured by Rath communication and shall incorporate text to talk, audio and visual communication. No substitute will be allowed.
b. “Push to Call” button or adjacent light jewel shall illuminate and flash when call is cknowledged. Button Shall match car operating panel pushbutton design. Provide

uppercase “PUSH TO CALL” “HELP ON THE WAY” engraved sign adjacent to button.Provide “Push to Call” button tactile symbol, engraved signage, and Braille adjacent to button mounted integral with car front return panel.Phone line monitoring with visual and audio indication shall be provided as required by the latest code ASME A17.1 item 2.27.1.1.6 Communication system shall be incorporated as part of the car station. No separate surface mounted fixture will be allowed.

Submittals

A. Within (30) Thirty calendar days after award of contract and before beginning equipment fabrication submit shop drawings and required material samples for review. h

B. Scaled or Fully Dimensioned Layout: Machine Room indicating equipment arrangement, elevation section hoistway and machines with tiedowns and retained equipment.

C. Design Information: Indicate equipment lists, reactions, and design information on layouts for new machines. Design information shall include verification that new and existing reactions do not exceed original building design (If existing) by more than 5% as required by code. New Reactions or if existing building that exceed the original building design criteria by more than 5% shall be reviewed and verified by a licensed professional engineer.

D. Power Confirmation Information: Design for existing conditions for modernization projects.

E. Fixtures: Shop Drawings with A.D.A. References, Cuts and samples

F. Cabs: Detail cab and ceiling drawings, including finishes.

G. Door equipment drawings, Car and Hoistway

H. Finish Material: Submit 3" x 12" samples of actual finished material for review of color, pattern, and texture. Compliance with other requirements is the exclusive responsibility of the Contractor. Include, if requested, signal fixtures, lights, graphics, Braille plates, and detail of mounting provisions.

I. Design Information: Provide calculations verifying the following for new or existing:
  c. Adequacy of existing electrical provisions.
  d. Adequacy of retained equipment relative to code requirements if car weight increased by more than 5%.
  e. Machine room heat emissions in B.T.U.
  f. Adequacy of existing retained elevator machine beams.

J. Adequacy of car platform structure for intended loading.

K. Written Maintenance Control Program (MCP) specifically designed for the equipment included under this contract. Include any unique or product specific procedures or methods required to inspect or test the equipment. In addition, identify weekly, bi- weekly, monthly, quarterly, and annual maintenance procedures, including statutory and other required equipment tests.

L. Submittal review shall not be construed as an indication that submittal is correct or suitable or that the work represented by submittal complies with the Contract Documents. Compliance with Contract Documents, Code requirements, dimensions, fit, and interface with other work is Contractor’s responsibility.

M. Acknowledge and/or respond to review comments within (7) Seven calendar days of return. Promptly incorporate required changes due to inaccurate data or incomplete definition so that delivery and installation schedules are not affected. Identify and cloud drawing revisions including Contractor elective revisions on each re-submittal. Contractor’s revision response time is not justification for equipment delivery or installation delay.

14 39 90 – Mockups

Description:

Section includes administrative and procedural requirements for quality assurance and quality control. Testing and inspection services are required to verify compliance with requirements specified or indicated. These services do not relieve Contractor of responsibility for compliance with the Contract Document requirements.

A. Specific quality-assurance and quality-control requirements for individual work results are specified in their respective Specification Sections. Requirements in individual Sections may also cover production of standard products.

B. Specified tests, inspections, and related actions do not limit Contractors other quality-assurance and quality-control procedures that facilitate compliance with the Contract Document requirements.

C. Requirements for Contractor to provide quality-assurance and quality-control services required by Architect, Owner, Commissioning Authority, or authorities having jurisdiction are not limited by provisions of this Section.

Definitions:

A. Mockups: Physical assemblies of portions of the Work constructed to establish the standard by which the Work will be judged. Mockups are not Samples.

1. Mockups are used for one or more of the following:
    a. Verify selections made under Sample submittals.
    b. Demonstrate aesthetic effects.
    c. Demonstrate the qualities of products and workmanship.
    d. Demonstrate successful installation of interfaces between components and systems.
    e. Perform preconstruction testing to determine system performance.
2. Product Mockups: Mockups that may include multiple products, materials, or systems specified in a single Section.
3. In-Place Mockups: Mockups constructed at an approved location by ower, on-site in their actual final location as part of permanent construction.
4. Room Mockups: Mockups constructed on-site or at a location approved by Owner, that identify the room layout and the FF&E products to allow users to review and comment. h

ACTION SUBMITTALS:

A. Mockup Shop Drawings:

1. Include plans, sections, elevations, and details, indicating materials and size of mockup

construction.

2. Indicate manufacturer and model number of individual components.
3. Provide 3D drawings for conditions difficult to illustrate in two dimensions.

REPORTS AND DOCUMENTS:

A. Test and Inspection Reports: Prepare and submit certified written reports specified in other Sections. Include the following:

1. Date of issue.
2. Project title and number.
3. Name, address, telephone number, and email address of testing agency.
4. Dates and locations of samples and tests or inspections.
5. Names of individuals making tests and inspections.
6. Description of the Work and test and inspection method.
7. Identification of product and Specification Section.
8. Complete test or inspection data.
9. Test and inspection results and an interpretation of test results.
10. Record of temperature and weather conditions at time of sample-taking and testing and inspection.
11. Comments or professional opinion on whether tested or inspected Work complies with the Contract Document requirements.
12. Name and signature of laboratory inspector.
13. Recommendations on retesting and reinspecting.

B. Coordinate Test and Inspection Reports for Exterior Envelope Mockups with the Building Envelope Commissioning Agent

QUALITY ASSURANCE:

A. Qualifications paragraphs in this article establish the minimum qualification levels required; individual Specification Sections specify additional requirements.

B. Manufacturer Qualifications: A firm experienced in manufacturing products or systems similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units. As applicable, procure products from manufacturers able to meet qualification requirements, warranty requirements, and technical or factory-authorized service representative requirements.

C. Fabricator Qualifications: A firm experienced in producing products similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.

D. Installer Qualifications: A firm or individual experienced in installing, erecting, applying, or assembling work similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful in-service performance.

E. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of the system, assembly, or product that is similar in material, design, and extent to those indicated for this Project.

F. Specialists: Certain Specification Sections require that specific construction activities be performed by entities who are recognized experts in those operations. Specialists will satisfy qualification requirements indicated and engage in the activities indicated.

1. Requirements of authorities having jurisdiction supersede requirements for specialists.

G. Testing and Inspecting Agency Qualifications: An NRTL, an NVLAP, or an independent agency with the experience and capability to conduct testing and inspection indicated, as documented in accordance with ASTM E329, and with additional qualifications specified in individual Sections; and, where required by authorities having jurisdiction, that is acceptable to authorities.

H. Manufacturer's Technical Representative Qualifications: An authorized representative of manufacturer who is trained and approved by manufacturer to observe and inspect installation of manufacturer's products that are similar in material, design, and extent to those indicated for this Project.

I. Factory-Authorized Service Representative Qualifications: An authorized representative of manufacturer who is trained and approved by manufacturer to inspect, demonstrate, repair, and perform service on installations of manufacturer's products that are similar in material, design, and extent to those indicated for this Project.

J. Preconstruction Testing: Where testing agency is indicated to perform preconstruction testing for compliance with specified requirements for performance and test methods, comply with the following Contractor’s responsibilities, including the following:

1. Provide test specimens representative of proposed products and construction.
2. Submit specimens in a timely manner with sufficient time for testing and analyzing results to prevent delaying the Work.
3. Provide sizes and configurations of test assemblies, mockups, and laboratory mockups to adequately demonstrate capability of products to comply with performance requirements.
4. Build site-assembled test assemblies and mockups, using installers who will perform same tasks for Project.
5. When testing is complete, remove test specimens and test assemblies, and mockups; do not reuse products on Project.
6. Testing Agency Responsibilities: Submit a certified written report of each test, inspection, and similar quality-assurance service to Architect and Commissioning Authority, with copy to Design-Builder. Interpret tests and inspections, and state in each report whether tested and inspected Work complies with or deviates from the Contract Documents.

K. Mockups: Before installing portions of the Work requiring mockups, build mockups for each form of construction and finish required to comply with the following requirements, using materials indicated for the completed Work:

1. Building Envelope Mockups shall be built ***PRIOR*** to the actual building construction and shall be constructed with the actual proposed materials, systems and details proposed. Testing in accordance with Building Envelope Commissioning Agentv
2. Build mockups of size indicated.
3. Build mockups in location indicated or, if not indicated, as directed by Architect and ASU

Design and Project Manager.

4. Notify Architect and ASU Design and Project Manager seven (7) days in advance of dates and times when mockups will be constructed.
5. Employ supervisory personnel who will oversee mockup construction. Employ workers who will be employed to perform same tasks during the construction at Project.
6. Demonstrate the proposed range of aesthetic effects and workmanship.
7. Obtain Architect's and ASU Design and Project Manager approval of mockups before starting corresponding Work, fabrication, or construction.

L. Allow fourteen (14) days for initial review and each re-review of each mockup.

1. Promptly correct unsatisfactory conditions noted by Owner or Architect's preliminary review, to the satisfaction of the Owner and Architect, before completion of final mockup.
2. Approval of mockups by the Owner and Architect does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect and ASU Design and Project Manager specifically approves such deviations in writing.
3. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
4. Demolish and remove mockups when directed unless otherwise indicated.

QUALITY CONTROL:

A. Owner Responsibilities: Where quality-control services are indicated as Owner's responsibility, Owner will engage a qualified testing agency to perform these services.

1. Owner will furnish Contractor with names, addresses, and telephone numbers of testing agencies engaged and a description of types of testing and inspection they are engaged to perform.
2. Costs for testing will be included in contract.
3. Costs for retesting and reinspecting construction that replaces or is necessitated by Work that failed to comply with the Contract Documents will be charged to Contractor.

B. Contractor Responsibilities: Tests and inspections not explicitly assigned to Owner are Contractor responsibility. Perform additional quality-control activities, whether specified or not, to verify and document that the Work complies with requirements.

1. Unless otherwise indicated, provide quality-control services specified and those required by authorities having jurisdiction. Perform quality-control services required of Contractor by authorities having jurisdiction, whether specified or not.
2. Engage a qualified testing agency to perform quality-control services.
3. Contractor will not employ same entity engaged by Owner, unless agreed to in writing by Owner.
4. Notify testing agencies at least twenty-four (24) hours in advance of time when Work that requires testing or inspection will be performed.
5. Where quality-control services are indicated as Contractor responsibility, submit a certified written report, in duplicate, of each quality-control service.
6. Testing and inspection requested by Contractor and not required by the Contract Documents are Contractor’s responsibility.
7. Submit additional copies of each written report directly to authorities having jurisdiction, when they so direct.

C. Retesting/Reinspecting: Regardless of whether original tests or inspections were Contractor’s responsibility, provide quality-control services, including retesting and reinspecting, for construction that replaced Work that failed to comply with the Contract Documents.

D. Testing Agency Responsibilities: Cooperate with Architect and ASU Design and Construction Manager, Commissioning Authority, and Contractor in performance of duties. Provide qualified personnel to perform required tests and inspections.

1. Notify Architect, ASU Design and Construction Manager, Commissioning Authority, and Contractor promptly of irregularities or deficiencies observed in the Work during performance of its services.
2. Determine the locations from which test samples will be taken and in which in-situ tests are conducted.
3. Conduct and interpret tests and inspections, and state in each report whether tested and inspected Work complies with or deviates from requirements.
4. Submit a certified written report, in duplicate, of each test, inspection, and similar quality-control service through Contractor.
5. Do not release, revoke, alter, or increase the Contract Document requirements or approve or accept any portion of the Work.
6. Do not perform duties of Contractor.

E. Manufacturer's Field Services: Where indicated, engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including service connections. Report results in writing as specified in Section 013300 "Submittal Procedures."

F. Manufacturer's Technical Services: Where indicated, engage a manufacturer's technical representative to observe and inspect the Work. Manufacturer's technical representative's services include participation in preinstallation conferences, examination of substrates and conditions, verification of materials, observation of Installer activities, inspection of completed portions of the Work, and submittal of written reports.

G. Contractor’s Associated Requirements and Services: Cooperate with agencies and representatives performing required tests, inspections, and similar quality-control services, and provide reasonable auxiliary services as requested. Notify agency sufficiently in advance of operations to permit assignment of personnel. Provide the following:

1. Access to the Work.
2. Incidental labor and facilities necessary to facilitate tests and inspections.
3. Adequate quantities of representative samples of materials that require testing and inspection. Assist agency in obtaining samples.
4. Facilities for storage and field curing of test samples.
5. Delivery of samples to testing agencies.
6. Preliminary design mix proposed for use for material mixes that require control by testing agency.
7. Security and protection for samples and for testing and inspection equipment at Project site.

H. Coordination: Coordinate sequence of activities to accommodate required quality-assurance and quality-control services with a minimum of delay and to avoid necessity of removing and replacing construction to accommodate testing and inspection.

1. Schedule times for tests, inspections, obtaining samples, and similar activities.

I. Schedule of Tests and Inspections: Prepare a schedule of tests, inspections, and similar quality-control services required by the Contract Documents as a component of Contractor quality-control plan. Coordinate and submit concurrently with Contractor Construction Schedule. Update and submit with each Application for Payment.

1. Schedule Contents: Include tests, inspections, and quality-control services, including Contractor - and Owner - retained services, commissioning activities, and other Project-required services paid for by other entities.
2. Distribution: Distribute schedule to Owner, Architect, ASU Design and Project Manager, Commissioning Authority, testing agencies, and each party involved in performance of portions of the Work where tests and inspections are required.

SPECIAL TESTS AND INSPECTIONS:

A. Special Tests and Inspections: Owner will engage a qualified testing agency and/or[special inspector to conduct special tests and inspections required by authorities having jurisdiction as the responsibility of Owner as follows:

1. Verifying that manufacturer maintains detailed fabrication and quality-control procedures, and reviewing the completeness and adequacy of those procedures to perform the Work.
2. Notifying Architect, ASU Design and Project Manager, Commissioning Authority, and Contractor promptly of irregularities and deficiencies observed in the Work during performance of its services.
3. Submitting a certified written report of each test, inspection, and similar quality-control service to Architect, ASU Design and Project Manager, and Commissioning Authority, with copy to Contractor and to authorities having jurisdiction.
4. Submitting a final report of special tests and inspections at Substantial Completion, which includes a list of unresolved deficiencies.
5. Interpreting tests and inspections, and stating in each report whether tested and inspected Work complies with or deviates from the Contract Documents.
6. Retesting and reinspecting corrected Work.

EXECUTION

TEST AND INSPECTION LOG:

A. Test and Inspection Log: Prepare a record of tests and inspections. Include the following:

1. Date test or inspection was conducted.
2. Description of the Work tested or inspected.
3. Date test or inspection results were transmitted to Architect.
4. Identification of testing agency or special inspector conducting test or inspection.

B. Maintain log at Project site. Post changes and revisions as they occur. Provide access to test and inspection log for Architect's, ASU Design and Project Manager, Commissioning Authority's, and authorities' having jurisdiction reference during normal working hours.

1. Submit log at Project closeout as part of Project Record Documents.

REPAIR AND PROTECTION:

C. General: On completion of testing, inspection, sample-taking, and similar services, repair damaged construction and restore substrates and finishes.

1. Provide materials and comply with installation requirements specified in other Specification Sections or matching existing substrates and finishes. Restore patched areas and extend restoration into adjoining areas with durable seams that are as invisible as possible. Comply with the Contract Document requirements for cutting and patching in Section 017300 "Execution."

D. Protect construction exposed by or for quality-control service activities.

E. Repair and protection are Contractor’s responsibility, regardless of the assignment of responsibility for quality-control services.

DIVISION 20 - COMMON WORK RESULTS FOR MECHANICAL AND PLUMBING

20 00 00 - General Requirements

General

A. These guidelines have been established to address the most common project elements at ASU. They are to be used in conjunction with the requirements set forth by applicable codes, laws and ordinances of this jurisdiction, recognized industry standards, good industry practice and specific program needs. Omission of reference in these guidelines does not relieve responsibility for compliance with these requirements.

B. The provisions of these guidelines are not intended to prohibit the use of alternative systems, methods or components. Due diligence shall be performed to ensure the design is equivalent or superior to the prescribed elements of the guideline. Modifications to the guidelines shall be proposed to meet specific project goals, conditions and requirements through ASU’s formal variance process.

Demolition

A. Abandoned utilities shall be demolished back to the nearest main or riser as is practical per the scope of the work area. Due to health concerns, all abandoned potable water piping shall be demolished back to the nearest main or riser so as to not create a dead leg where water may collect.

B. Confirm any materials that are to be salvaged and returned to ASU.

Installations

A. Distribution systems shall be installed level and plumb, without sags, and parallel and perpendicular to building structures and other systems and components in a neat and workmanlike manner. Each system shall be independently supported unless the support system has been engineered to accommodate the loads of the additional systems.

B. Provide access where serviceable equipment and components are located above hard-lid ceilings, in chases, or in otherwise inaccessible locations.

Products

A. Unless directed by ASU to reuse components, use only products that are new, first quality, and free from defects in workmanship and materials.

B. New products shall be by reputable manufacturers who have been manufacturing and distributing the product for at least five years unless otherwise approved by ASU.

C. Use the same manufacturer for like equipment or material as possible, unless otherwise indicated or directed by ASU.

D. Systems and components shall be selected to maximize the utilization of competitive standard elements.

E. Products and materials shall be suitable for use, meeting system temperature and pressure requirements and shall be fire retardant, chemical, weather, UV resistant, etc. as required of the application. All products shall be asbestos free.

Vibration/Sound Control

A. Adequate isolation shall be provided at equipment, including the systems they serve, to minimize the transmission of vibration and noise from being transmitted to building components and occupied spaces. Unless otherwise noted in the project requirements, establish design goals according to good engineering practice and the ASHRAE design goals for sound control. For applications where controlling vibration and sound is critical, it is recommended that a vibration/acoustical consultant be engaged.

B. Isolators shall be selected and located to provide uniform loading and deflection based on the lowest disturbing operating frequency of the equipment. Flexible connections shall be compatible with the operating conditions of the system, weatherproof and fire resistant as required.

Piping

A. General

1. All materials shall be certified new from the factory. Pipe, and weld fittings and valves shall be made in the USA or Canada to ANSI/ASME standards and suitably stamped. Piping made in other countries shall not be used unless specifically approved.
2. Pipe systems shall be designed and installed to allow complete venting and drainage. Slopes shall be uniform without pockets. Automatic vents shall be located on drawings and piped to a suitable and visible location.
3. Locate groups of pipes parallel to each other, spaced to permit future connections and servicing of valves.
4. Pipe shall not be routed through transformer vaults or above transformers, panelboards or switchboards, including required service space for the equipment, unless piping is serving this equipment.
5. Wrap piping when passing through sleeves. Pipe shall not come in contact with other systems or the building structure.
6. Pipe joints, no-hub clamps, flanges, unions, etc., shall not directly contact or be encased in concrete, or be located within wall, floor, or roof penetrations.
7. All piping shall have reducing fittings used for reducing or increasing where any change in the pipe sizes occurs. Bushings shall not be used.
8. Bullhead tees shall not be used at converging intersections.
9. Provide for condensate piping union connection from equipment and threaded plug cleanouts at change in directions except for the final turndown to drain. Insulate as necessary if condensation may occur.h
10. Provide a corrosion protection system for underground steel piping as recommended by the soils engineer. System shall be provided by a contractor regularly engaged in such systems and supervised by an accredited engineer.

B. Evaporator and Cooling Coil Condensate Piping

1. Outdoor or Indoor
    a. Copper
        i. Pipe: Type M, drawn, ASTM B88.
        ii. Joints: 95-5 tin-antimony solder, ASTM B32.
        iii. Fittings: Wrought copper, ASTM B16.22.
2. Indoor Only (requires pre-approved variance by ASU special attention must be given to smoke generation). Pipe and Fittings shall meet max flame spread index of 25 and max smoke development index of 50. ASTM E84, UL723.
    a. CPVC
        i. Pipe: ASTM D1784, ASTM F441, Schedule 40.
        ii. DWV Fittings: ASTM D2665, Socket pattern with low VOC solvent

cemented Joints

C. Solar Hot Water

1. Stagnant pipe systems may experience extreme high temperature conditions. Generally Type L or K copper, black steel and stainless steel are appropriate materials for the piping system, however when choosing materials for the collector loop, the solar system vendor should be consulted to understand the extreme conditions of the system being proposed. Care must be taken in using Teflon tape to seal threaded pipe joints when water /glycol is being circulated in the pipes. With proper dielectrics, black steel piping can be used on the collector side for use with glycol systems.

D. Grooved Couplings and Fittings

1. Grooved fittings and couplings shall be allowed based on application and owner written approval. Mechanically formed tee connections and couplings shall not be used.

E. Unions and Flanges

1. Unions and flanges shall meet the listed service and the applicable standards for the pipe materials used. Provide unions and/or flanges at equipment, valves and accessories that require maintenance and removal. Arrange valves, unions and flanges to allow for equipment removal without system shutdown. Provide dielectric unions or flanges at connections of dissimilar materials.

F. Valves and Specialties

1. Valves and specialties shall be located for convenience of operation and maintenance. Plans shall clearly identify the location and/or provisions for accessibility, withdrawal of tube bundles and the like. The mechanical and architectural designs shall be coordinated to show any platforms needed, or access panels in walls, ceilings, etc. as required for proper operation, maintenance or inspection of the system components.
2. Isolation valves shall be installed at each floor off of risers, each branch line off of mains, and each piece of equipment and terminal unit. They should be readily accessible for emergency or maintenance work. Provide gear operators for valves 6 inches and larger. In mechanical rooms, provide chain-wheel operators for valves 6 inches and larger, installed 96 inches or higher above finished-floor elevation.
3. Install bypass valves around each pressure-reducing valve/station and major equipment control valve using throttling type valves. If multiple, parallel control valves are installed, only one bypass is required. In this case, where pressure differing capacity control valves are used (such as 1/3 - 2/3 configurations), size the bypass for the largest valve capacity. This requirement is not intended for control valves at terminal unit equipment unless required of the critical nature of the program.
4. Provide spring-loaded type check valves on discharge of water pumps.
5. Where areas will be typically restricted, it is important that any serviceable equipment be located outside these areas.
6. Use rising stem or rising outside screw and yoke stems. Install valves in a position to allow full stem movement. Use extended stems where insulation dictates. Install valves with the stem at or above the centerline of the pipe.
7. Use threaded or flanged connections at valves.
8. Drains shall be full port ball valves with cap and chain.
9. Balancing valves shall not be used as isolation valves.
10. Gate valves (when approved) shall not be used as balancing valves.
11. Chilled or hot water distribution systems shall use high performance valves with true stops.

G. Gauges

1. Install gauges on systems and equipment to aid in troubleshooting and where maintenance is required. Gauges shall be readily visible.
2. Pressure:
    a. Minimum 4-1/2” dial, accurate to ANSI B40.1 Grade 1A.
    b. Provide with snubbers and gauges valves.
    c. Provide with coil syphons and gauge valves on hot pressure media such as steam systems.
    d. At a minimum, provide at these locations:
        i. Building entrances.
        ii. Suction and discharge of each pump.
        iii. Upstream and downstream of each pressure-regulating device.
        iv. Upstream and downstream of filters, separators and pump strainers.
        v. Upstream and downstream of chillers and hot water heaters/boilers.
        vi. Upstream and downstream of each coil, or coil bank, in air handling units.
        vii. Pressurized tanks/receivers.
3. Temperature
    a. Pipeline mounted: minimum 9” with mercury-free fill and adjustable angle stem.
    b. Panel or remote mounted: minimum 4-1/2” dial.
    c. At a minimum, provide at these locations:
        i. Building entrances.
        ii. Upstream and downstream of main system mixing valves.
        iii. Upstream and downstream of each, boiler, chiller and heat exchangers.
        iv. Upstream and downstream of each coil, or coil bank, in air handling units.
        v. Upstream and downstream of each heat recovery unit.
        vi. Upstream, downstream, and at each thermal storage tank.
4. Pressure/Temperature Test Stations
    a. At a minimum, install upstream and downstream of:
        i. At each individual coil in air handling units with multiple coils.
        ii. Each terminal coil.
        iii. Each heat exchanger/converter.
5. Strainers
    a. Provide drain valve at each strainer blowdown with hose threaded adapter and cap.
    b. At a minimum, install upstream of:
        i. Each hydronic coil.
        ii. Each control valve (not required for control valve is located downstream of a hydronic coil).

   - iii. Each pump.
   - iv. Each pressure reducing valve.
   - v. Each steam trap.
   - vi. Each metering device.

6. Testing
   - a. The Design Professional shall specify testing procedures, including type of test, pressures and durations. At a minimum, such procedures shall comply with the requirements of the jurisdiction and recognized industry standards.
   - b. Verify systems are complete, flushed and clean prior to testing.
   - c. Isolate all equipment subject to damage from test pressure.
   - d. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired.
   - e. Leave systems uninsulated, uncovered and unconcealed until it has been tested and approved. All pressure testing shall be witnessed and documented with results approved and signed off by an ASU representative and the Design Professional. Provide two week notice prior to witness test. Maintain a set of drawings for recording and sign-off of each tested section.
   - f. Where any portion of piping system must be concealed before completion of entire system, the portion shall be tested separately as specified for the entire system prior to concealment. Contractor shall expose all untested covered or hconcealed piping for testing.
   - g. Defective work or material shall be replaced or repaired as necessary and inspection and test repeated. Repairs shall be made with new materials.
   - h. In no case shall plastic piping be subjected to pneumatic testing unless specifically approved by the manufacturer.

<u>Penetrations</u>

A. <u>General</u>

1. Sleeves shall be provided for pipes and duct passing through walls or floors. Sleeves shall be cut flush with each surface unless otherwise specified. Sleeve sizes shall be a minimum of 1” larger in diameter than the pipe, and no more than 1/2” larger in all sides of duct. Sizes shall be adjusted as required of the firestopping system and to compensate for insulation without binding.
2. In bearing walls, masonry walls and partitions, and interior floors: pipe sleeves shall be standard weight steel pipe with smooth ends, and duct sleeves shall be 10-gauge galvanized sheet metal. All other sleeves shall be minimum 24 gauge sheet steel.
3. Where the floor, wall or partition is fire rated, provide a UL-approved firestop/sealant system specific for the conditions, conforming to the construction assembly type, penetrating item type, annular space requirements and fire-rating for each separate instance.
4. Sealants shall be compatible for use with the penetrating item.

B. Exterior wall penetrations

   - a. Seal pipe penetrations through exterior walls using sleeves with integral water stop (formed) or split sleeves (cores) and modular, mechanical seals. Sealing system shall utilize 316 stainless steel bolts, washers and nuts. Other methods of sealing shall be considered where conditions dictate.

C. Interior wall penetrations

1. Seal around sleeve and annular space as required. Provide escutcheons on exposed side of piping.

D. Floor penetrations

1. Seal around sleeve and annular space as required.
2. In mechanical rooms above grade: pipe penetrations shall have 4-inch high water stopped curbs or sleeves around the pipe, and duct penetrations shall have 4” high water stopped curbs. All other floor penetrations shall extend a minimum of 1-1/2” inches above the floor.

20 05 13 - Motors

A. Motor installations shall comply with NEMA, IEEE, ANSI and NEC standards and listed when required. Motors shall be designed and protected for the environment and conditions in which they will perform. Motors shall be selected to not exceed the nameplate rating nor continuously operate into motor service factor. Motors shall be rated for continuous duty and have a 1.15 service factor unless required otherwise.

B. The minimum full load nominal efficiency for 1 hp and larger motors shall be premium efficiency type, established in accordance with NEMA MG-1 for the specific use of the motor. Motors less than 1/2 hp shall be single phase and furnished with built-in thermal overload protection. Motors 1/2 hp and larger shall be polyphase and provided with overload protection.

C. Select motors with sufficient hp rating for non-overloading operation over entire pump/fan curves.

D. Select motor controller features for the characteristics of the supply and control circuits and control sequence and duty cycle of the motor. Magnetic starters shall be provided for all motors over 1/2 hp. Provide reduced voltage starters as required to limit voltage sag in excess of 3%, or where other requirements dictate. Coordinate with ASU BAS the motors and equipment that will require control through the central building automation system.

E. Motors driven by variable frequency drives shall comply with the latest NEMA MG-1, Section IV, Part 31. Provide protection from bearing current damage as recommended by the motor manufacturer.

F. Motors less than 1/2 hp shall have permanently lubricated and sealed ball bearings. Motors 1/2 hp and larger shall have lubricating bearings with one grease fitting and one removable plug in the bottom of the grease sump per bearing to provide for flushing and pressure relief during lubrication.

G. Preference is for factory-mounted motor starters to be provided with circuit breakers in lieu of fuses. Motor lead connections shall be made by industry-approved methods of connection. Twist-on wire connections are not allowed.

H. The location of six and eight pole motors shall be limited to on slab-on-grade applications.

20 05 29 - Supporting Devices

A. Support for all conditions of operation, including variations between static and dynamic loading. Systems shall be designed to allow for proper expansion and contraction. Such expansion and contraction should be controlled with hangers and supports as required to lessen forces and moments on equipment, and reduce the over-stress of the piping itself.

B. The use of expansion loops (non-flexible) is preferred over expansion joints unless the arrangement is such that only an expansion joint can meet the conditions. In particular, expansion joints shall be avoided for steam systems, utilities in tunnels and areas where a leak would be extremely hazardous or costly. Where expansion joints are used, they shall be fully accessible for repair/replacement.

C. Anchor points shall be shown on the drawings. Check to see that the structure which serves to anchor the piping is adequate for the force exerted. Any additional steel required should be detailed on the plans.

D. Where cold springing is used to control expansion, the amount and point of application shall be shown on the plans.

E. Thrust blocks and restraints shall be provided as necessary to prevent movement of underground mechanical joints unless an approved joint system is used.

F. Insulation shall be sufficiently protected at each support to prevent damage due to static and dynamic loading with shields and inserts, saddles, etc. Material, thickness, compression strength, vapor barrier treatment and load-bearing surface shall be considered for each system. Wood inserts are not allowed.

G. Isolate all bare copper pipes from ferrous building materials. Tape wrap is not an acceptable isolator.

H. Provide vinyl-coated hangers for all plastic piping.

20 05 53 - Identification

Pipe Identification:

A. Identify piping in accordance with ANSI Standard A13.1. Place markers:

1. Near valves, flanges and changes in pipe direction.
2. At both sides of ceiling, wall or floor penetrations.
3. At any line entry point.
4. At frequent intervals on straight pipe runs not less than every 25 feet.
5. Not less than once in each room.
6. At each branch.
7. Adjacent to each access door or panel.
8. Locate pipe markers so they are visible from the point of normal approach.
9. Provide arrows at one or both ends of the label to indicate direction of flow.

Valve Identification:

A. Identify all valves within the scope of the project whether exposed or concealed with brass tags and chains with 1/2” stamped or engraved characters. Use stainless steel chains for stainless valves. Coordinate valving tag numbering sequence with Facilities Development and Management (FDM).

B. Equipment Identification:

C. Identify all equipment with engraved laminated plastic with white lettering and black background. Lettering/numbering will be no less that 3/4 inches in height. Nameplates exposed to sunlight will be made of UV-resistant material.

D. Provide operational data including manufacturer, product name, model number, serial number, capacity, operating and power characteristics, labels of tested compliances, and similar essential data. Locate nameplates in an accessible location.

20 07 00 - Insulation

A. Insulation shall be provided in accordance with ASHRAE 90.1 and good engineering practice.

Additional systems requiring insulation, or additional insulation thickness over the ASHRAE minimum, shall be provided where operating cost savings will offset the cost of the insulation within its life expectancy, to provide additional protection to building components and occupants and to prevent condensation.

B. Materials shall be fire retardant, moisture, mildew and weather/U.V. resistant, vermin proof and suitable for its service. Pipe insulation inserts shall be crush- and rot-resistant. Wood inserts are not allowed. Provide jackets to protect insulation from damage and/or reduce vapor transmission.

C. Exterior rectangular duct insulation shall be pitched to prevent ponding. Exterior pipe and round duct insulation jackets shall overlap and terminate at 45 degrees below horizontal to prevent water from seeping into the jacket.

D. All exposed insulation installed up to 6’ above finished floor shall be further protected from damage with lagging.

E. Install materials with joints and terminations to readily allow access to equipment and components where inspection, service or repair is required, and to allow for system expansion/contraction without damaging the materials.

F. Vapor barriers shall be installed on insulated pipes, ducts and equipment having surface operating temperatures below 650F. Other conditions may warrant the application of vapor barriers on surfaces above this temperature and shall be analyzed on a case-by-case basis.

G. Installation methods shall be performed in accordance with the latest edition of the National Commercial and Industrial Insulation Standards manual and manufacturer’s installation instructions. Use full length factory furnished material where possible; scraps are not allowed.

DIVISION 21 - FIRE SUPPRESSION

21 10 00 - Fire Protection Systems

A. All current NFPA codes and standards shall apply with the additions noted below:

1. Acceptance
   a. Prior to any test by ASU and/or the Fire Code Official, a complete system with no troubles or alarms (Green Panel) must be confirmed. Testing will be at the discretion EHS Fire Safety and Prevention in conjunction with ASU’s Fire Systems Support Technologies (ASU FSST) unit thorough Facilities Management.

   b. 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.

   c. 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.

   d. 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.

   e. 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.

f. 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. All notices must be in writing via email to asufire@asu.edu and must include all fire safety personnel and the ASU project manager.

g. If removing, relocating, modifying, or adding any fire hydrant, standpipe, fire line, or sprinkler systems or devices, contractor shall provide deferred submittals to the ASU Fire Marshal's Office, prior to the actual work being performed.

h. Existing Fire alarm or sprinkler system devices that will remain in operation shall not be obstructed or disabled during construction/renovation.

i. All fire sprinkler systems shall adhere to the applicable IFC, IBC, NFPA, ASU Design Guidelines, and EHS Fire Safety and Prevention / ASU Fire Systems Support Technologies (FSST) requirements.

j. All sprinkler heads within the affected area of new construction or renovation shall be the appropriate style of "Quick Response" type of heads, unless otherwise required by code for special occupancies.

k. Any new piping for heads where possible shall be installed in an up and over configuration. Heads will not be dropped directly off the branch line. This will assist with keeping debris in the lines from blocking the heads.

l. Separate deferred submittals are required for each sprinkler systems, fire pump, fire line, and fire hydrant work separate from fire line work.

m. If relocating any sprinkler heads, the existing head shall be replaced with a new head. NFPA 13 requires the installation of "only new sprinklers". No matter how simple; if the sprinkler head is manipulated, moved, etc. the existing head shall be replaced. The only alternative to replacement is to remove and test a reasonable quantity of existing heads in accordance with NFPA 25.

n. Flexible Heads (e.g. Flex Heads) shall not be installed unless directly approved by EHS Fire Safety and Prevention / ASU Fire Systems Support Technologies prior to approval of project to start.

o. A valid work order number with funds is necessary to cover the time and material involved in conducting the 100% acceptance inspection test.

2. Materials

a. All Sprinkler piping 6 inches or less in diameter shall be black steel schedule 40. Any type of thin wall or flexible piping shall not be accepted. Any sprinkler system piping larger than 6 inches in diameter and less than schedule 40 may be approved on a case by case submitted basis to EHS Fire Safety and Prevention. Galvanized piping is not acceptable for installation. Any grooved piping shall be roll grooved. No grooving that removes material from the pipe shall be allowed.

b. No plastic pipe of any type may be used on any fire protection system.

c. Hooking collar assemblies shall not be used for connecting sprinklers or drop nipples to sprinkler pipe.

3. Design standard

a. 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.

b. 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.

c. 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 where 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.

d. 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.

e. 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.

f. 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.

g. 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.

h. 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.

i. No sprinkler heads from any manufacturer, which incorporates 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.

j. No more than two (2) sprinkler heads shall be installed on one (1) inch piping.

k. Modifications of systems affecting 20 or fewer sprinklers shall not require hydrostatic testing in excess of normal system working pressure. Where additions or modifications are made to an existing system affecting more than 20 sprinklers, the new portion may be isolated and tested at not less than 200 psi for 2 hours.

l. All mechanical T's shall have the cut out affixed near the saddle for visual verification.

m. All sprinkler heads shall be located center of any ceiling tile system, if at all possible.

n. Water based systems shall not be charged with water during construction if the water flow indication alarm devices are not operational. Charging with water for testing is acceptable, but the system shall be drained after testing is complete.

o. Standpipes and Hose systems shall be designed, installed, tested, inspected, and maintained in accordance with NFPA 14 and all other applicable codes and standards.

p. Stock of Spare Sprinkler Heads shall be maintained on premises in accordance with the requirements set forth in NFPA 13 as follows to coincide with the type and temperature rating of the heads present in the building; A minimum of six spare heads shall be maintain for facilities with under 300 heads, a minimum of 12 spare heads shall be maintained for facilities having 300 to 1000 heads, for facilities having more than 1000 heads a minimum of 24 spare heads shall be maintained.

q. Valves on connections to water supplies, sectional control and isolation valves, and other valves in supply pipes to sprinkler and other fixed water based fire suppression systems shall be supervised by one of the following methods:

    1. Central station, proprietary, or remote station signaling service. For ASU properties the monitoring signal shall be received according to our current set procedures. The tamper device shall send a supervisory signal to the panel and the ASU Police Dispatch system. All new system construction shall require that valve be installed with the appropriate tamper devices and connected to the fire alarm system and secured by chain and padlock or any other method approved by the ASU FMO.

    2. Valves locked in the correct position. Chained and padlocked, or any other method approved prior to installation by the EHS Fire Safety and Prevention. Existing systems only that do not have tamper devices installed.

r. Fire Department Connections (FDC's):

    a. Do not obstruct access and visibility of any FDC, minimum 3' clearance in all directions minimum requirement.

    b. The following FDC thread requirements shall be followed for the designated ASU Campuses:

        - Tempe Campus – Crest Diameter 3.075", Root Diameter 2.859", Telerance = +/- .010", Male-Female Shake = .050", 6 R.H. Threads per inch. NOTE – Follow City of Tempe, Arizona 2 ½" Fire Department Threads.

        - Downtown Phoenix Campus / West Campus / Polytechnic Campus – NH 7.5 x 3.068 (referred to as the national standard thread).

s. All FDC's shall have Knox Locking FDC's ordered through the Knox Company and installed for all new construction projects, contact EHS Fire Safety and Prevention for ordering procedures.

4. Drawings

    a. One "as built" drawing shall be supplied for Capital Programs Management Group's (CPMG) Print Room.

    b. 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.

EHS Fire Safety and Prevention Fire Alarm Requirements to comply with the 2018 International Fire Code (IFC) Section 907.2.9.3 for Group R-2 college and university dormitories.

EHS Fire Safety and Prevention being the Authority Having Jurisdiction (AHJ) as designated by the Arizona Department of Forestry and Fire Management. Office of State Fire Marshal, has made the following determination to ensure the highest level of fire and life safety for ASU occupants housed in residential units.

Prior to this date, this area of the fire code has not been fully addressed in previous ASU projects. The need to establish an acceptable level of fire and life safety protection for ASU students and staff members occupying our facilities is vital to reducing ASU's overall risk.

There are two main terms used in this section of the fire code that need to be clarified to understand the requirements of this section.

A. Smoke Detection (detector-initiation device): A listed device that senses visible or invisible particles of combustion.

B. Smoke Alarm (notification device): A single or multiple station alarm responsive to smoke. A fire alarm system component such as a bell, horn, speaker, light or visual text display.

The code requires that an automatic smoke detection system to be installed in the following locations

A. Common spaces outside of dwelling units and sleeping units.

B. Laundry rooms, mechanical equipment rooms, and storage rooms.

C. All interior corridors serving sleeping units or dwelling units.

Required smoke alarms in dwelling units and sleeping units in Group R-2 occupancies operated by a college or university for student or staff housing shall be interconnected with the fire alarm system in accordance with NFPA 72.

Smoke alarms, single or multiple station shall be installed in the following areas

A. On the ceiling or wall outside each, separate sleeping area in the immediate vicinity of bedrooms.

B. In each room used for sleeping purposes.

C. In each story within a dwelling unit.

With the requirements for the installation of smoke detectors/smoke alarms defined, EHS Fire Safety and Prevention has determined the best level of fire and life safety for ASU personnel the following requirements shall be implemented in all Group R-2 College and University buildings.

The use and installation of 120v battery backup stand-alone smoke detector/alarm units within the sleeping/dwelling units is prohibited.

The use and installation of 120v battery backup smoke detector/alarm units within sleeping units in a dwelling unit interconnected to the fire alarm system is prohibited. This type of installation will only activate occupant notification within the individual unit. This type of installation will only provide a supervisory trouble signal to the panel in the case of a device activation, and not allow for building notification. This installation does not allow for the monitoring of the devices in case of failure or being disabled. The EHS Fire Safety and Prevention has determined this type of system installation does not provide adequate fire and life safety protection for the occupants in the Group R-2 College and University Dormitory environment.

To ensure an environment of fire and life safety for the occupants. The fire alarm system installed in a Group R-2 College and University dormitory shall consist of a full fire alarm system to include smoke detection and notification in all sleeping units and dwelling units within a Group R-2 College and University dormitory for student or staff housing.

The fire alarm system installed shall follow all current applicable fire codes and standards, to include any requirements set forth in the ASU Design Guidelines and the ASU Fire Marshal's Office.

DIVISION 22 - PLUMBING

22 11 00 - Facility Water Distribution

Part 1 - Products

Building Domestic Cold Water

A. Below Ground

1. Copper (2-1/2” and Smaller).
    a. Pipe: Type K, annealed, ASTM B88.
    b. Joints (when allowed): Lead free solder, ASTM B32. Joints are not allowed under concrete, below grade.
    c. Fittings: Copper pressure fittings, ANSI B16.18; wrought copper pressure fittings, ANSI B16.26.
2. Ductile Iron (3” and Larger)
    a. Pipe: Ductile iron, Class 52, AWWA C151, cement mortar lined, AWWA C104.
    b. Fittings: Cast bronze, ANSI B16.18; wrought copper, ANSI B16.22.
    c. Joints: Copper press-fit joints may be used with an approved variance by ASU.

B. Above Ground

1. Copper (2-1/2” and Smaller)
    a. Pipe: Type L, hard drawn, ASTM B88.
    b. Joints: Lead free solder, ASTM B32.
    c. Fittings: Cast bronze, ANSI B16.18; wrought copper, ANSI B16.22.
    d. Joints: Copper press-fit joints may be used with an approved variance by ASU.
2. Copper (3” and Larger)
    a. Pipe: Type L, hard drawn, ASTM B88.
    b. Joints: Brazed, AWS A5.8.
    c. Fittings: Cast bronze, ANSI B16.18; wrought copper, ANSI B16.22.
    d. Chrome plate finish any bare pipe subject to chemical exposure.

Building Domestic Hot Water

A. Below Ground

1. Copper (All Sizes)
    a. Pipe: Type K, annealed, ASTM B88.
    b. Joints (when allowed): Lead free solder, ASTM B32. Joints are not allowed below under concrete, below grade.
    c. Fittings: Copper pressure fittings, ANSI B16.18; wrought copper pressure fittings, ANSI B16.26.

C. Above Ground
1. Copper (2-1/2" and Smaller):
    a. Pipe: Copper tube, Type L, hard drawn, ASTM B88.
    b. Joints: Lead free solder, ASTM B32.
    c. Fittings: Cast bronze, ANSI B16.18; wrought copper, ANSI B16.22.
    d. Joints: Copper press-fit joints may be used with an approved variance by ASU.
2. Copper (3" and Larger)
    a. Pipe: Type L, hard drawn, ASTM B88.
    b. Joints: Brazed, AWS A5.8.
    c. Fittings: Cast bronze, ANSI B16.18; wrought copper, ANSI B16.22.

Valves

A. Isolation Valves
1. Ball valve, bronze body, full port, stainless steel ball and stem, quarter turn.
2. Butterfly valve, ductile iron body, lug type, stainless steel disc and stem.
3. Gate valves shall not be used unless pre approved by ASU.

B. Balancing Valves
4. Globe valve or angle globe valve, dezincification resistant brass or bronze, metering ports with position display, memory stop, multiple turn. Quarter turn valves shall not be used.

Water Hammer Arrestors

A. Provide water hammer arrestors at flush valves, quick-closing valves and where other potential locations for water hammer exists in accordance with Standard P.D.I. WH-201. Provide access panels at inaccessible locations.

Part 2 - Execution General

A. Provide loose key hose bibs in equipment rooms, public restrooms and roofs for the purpose of cleaning and maintenance.

B. All water outlets dispensing non-potable water shall have signage posted noting – "Water Not for Consumption".

C. Any other piping arrangement that may allow water to stagnate shall not be installed within domestic water systems. Valves installed for future connections shall not extend more than 24 inches from an active main.

D. Install shut-off valves at each fixture and piece of equipment, at each branch take-off from mains, at the base of each riser, and at each battery of fixtures.

E. Provide accessible check valves in the individual cold and hot water fixture supply lines serving mixing valve type faucets or assemblies having hose connection outlets that are not equipped with integral check stops.

F. Install a shutoff valve immediately upstream of each strainer.

G. The water utilized for tests shall be obtained from a potable source of supply.

22 13 00 - Facility Sewerage

Part 1 - Products

Building Sanitary Waste and Vent, Storm Drainage

A. Underground
  1. Cast Iron (15” and smaller)
    a. Pipe: Hubless, CISPI 301, ASTM A-888.
    b. DWV hFittings/Joints: Hubless with heavyweight no-hub couplings with stainless steel clamps, FM 1680 Class 1, ASTM C-1540.
  2. PVC (15” and smaller)
    a. Pipe: DWV, ASTM D2665.
    b. Fittings/Joints: Socket pattern with low VOC solvent cemented joints.
    c. Solid wall PVC no cellular or foam core pipe.
    d. Installations must be in strict conformance to ASTM D 2321 for proper bedding and backfill.
  3. PVC (15” and larger)
    a. Pipe: DWV, ASTM D2665.
    b. Fittings/Joints: Socket pattern with low Voc solvent cemented joints.
    c. Solid wall PVC no cellular or foam pipe core.
    d. Installations must be in strict conformance to ASTM D 2321 for proper bedding and backfill.

B. Forced Main Underground
  1. Copper (3” and smaller)
    a. Pipe: Type K, drawn, ASTM B88.
    b. Joints: Lead free solder, ASTM B32.
    c. DWV Fittings: Cast copper, ANSI B16.23; wrought copper, ANSI B16.29.
  2. Ductile Iron (4” and Larger)
    a. Pipe: Ductile iron, Class 52, AWWA C151, cement mortar lined, AWWA C104.
    b. DWV Fittings/Joints: Mechanical joint with restrained, elastomeric gasket and lubricant, AWWA C111.
    c. Encasement: Polyethylene encasement of pipe and fittings, AWWA C105.

C. Above Ground
  1. Copper (3” and smaller)
    a. Pipe: Type M, drawn, ASTM B88.
    b. Joints: Lead free solder, ASTM B32.
    c. DWV Fittings: Cast copper, ANSI B16.23; wrought copper, ANSI B16.29.

2. Cast Iron (any size)
    a. Pipe: Hubless, CISPI 301, ASTM A-888.
    b. DWV Fittings/Joints: Hubless with heavyweight no-hub couplings with stainless steel clamps, FM 1680 Class 1, ASTM C-1540.

D. Forced Main Above Ground
  1. Copper (2-1/2" and smaller)
    a. Pipe: Type L, drawn, ASTM B88.
    b. Joints: Lead free solder, ASTM B32.
    c. DWV Fittings: Cast copper, ANSI B16.23; wrought copper, ANSI B16.29.

E. Galvanized (3" and larger)
  1. Pipe: Sch. 40, Type F, Grade A, ASTM A53.
  2. DWV Fittings: Cast iron threaded drainage fittings, ASTM B16.12.

Laboratory Waste and Vent

A. Underground
  1. Cast Iron
    a. Pipe: High silicon, hubless, ASTM A518, similar to Duriron.
    b. DWV Fittings: Heavyweight no-hub couplings with stainless steel clamps.
  2. Polypropylene
    a. Pipe: Schedule 80, ASTM D4101, plain end, similar to Orion "Rionfulse".
    b. DWV Fittings: Socket fusion. Joints and joining procedure shall conform to ASTM 2657.

B. Above Ground
  1. Chlorinated Poly Vinyl Chloride (CPVC)
    a. DWV Pipe and fittings shall meet maximum flame spread index of 25 and a maximum smoke developed index of 50 when tested in accordance with ASTM E 84 and UL 723.
    b. Pipe and Fittings: Shall confirm to ASTM F2618 for chemical waste systems
    c. Fittings: Socket pattern with solvent cemented joints.
    d. Manufacture Spears LabWaste or Corzan.
  2. Polyvinylidene Fluoride (PVDF)
    a. DWV Pipe and fittings shall meet maximum flame spread index of 25 and a maximum smoke developed index of 50 when tested in accordance with ASTM E 84 and UL 723.
    b. Pipe and Fittings: Shall confirm to ASTM D3222 and ASTM F1673.
    c. Pipe Joining: Electrofusion joining method.
    d. Manufacture Georg Fischer Fuseal.

C. Sumps and Ejectors

  1. Pumps shall be epoxy or enamel cast iron, duplex type with lead-lag operation. Oil filled and air filled applications should be considered on an individual basis.

2. Submersible type sewerage pumps are preferred. Solid handling only. No grinder pumps. No self-primers.

Part 2 - Execution

General

Design Professional in selecting appropriate drain, waste, and vent system shall give consideration to the make-up of waste conveyed by the system, review of Geo-technical Soils Report for corrosive soils, groundwater, soil composition, stability and understanding of any live loads the piping system will be subject to. In addition to any additional considerations effecting the service life and maintenance requirements of the system for the life of the building structure. The Design Professional shall include in Project Design Narrative a review of project considerations in selection of drain, waste and vent system.

Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical. Use long-turn, double Y-branch and 1/8-bend fittings if two (2) fixtures are installed back-to-back or side-by-side with common drain pipe. Straight tees, elbows, and crosses may be used on vent lines. Do not change direction of flow more than 90 degrees.

Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.

Minimum size drain or vent pipe below slab shall be no less than 3”.

Test tees shall be used for testing waste and vent systems. Do not separate piping systems and cap ends for testing.

Floor drains shall be installed in equipment rooms, restrooms and locker rooms. Refer to Engineering Guidelines for equipment room requirements

All unburied change-of-direction fittings within the roof drainage system shall be braced against thrust loads that might result in joint separation due to dynamic forces caused by sudden, heavy rainfall conditions.

Sewer lines that pass through tunnels shall be continuous pipe without joints and penetrations and shall be sealed water tight.

Do not lay underground pipe directly on undisturbed or virgin soil. Provide an adequate homogenous layer of loose native or borrow backfill below and surrounding underground pipes to provide an even support for the pipe, improve drainage and reduce corrosion.

A. Cleanouts

1. Provide two-way clean-outs on building drains, outside the building.
2. Provide cleanouts at locations and with clearances as required by the code, at the base of each stack. Intervals shall not exceed 50 feet in horizontal runs without a variance. In no case shall the intervals exceed 70 feet.
3. All interior cleanouts shall be accessible from walls or floors. Provide wall cleanouts in lieu of floor cleanouts wherever possible. A floor cleanout shall be installed only where installation of a wall cleanout is not practical. Coordinate the location of all cleanouts with the architectural features of the building.
4. Provide a wall cleanout for each water closet or battery of water closets. Locate wall cleanouts above the flood level rim of the highest water closet but no more than twenty four inches above the finished floor.
5. Lubricate cleanout plugs with anti-seize lubricant before installation. Prior to final completion, remove cleanout plugs, re-lubricate and reinstall using only enough force to provide a water and gas-tight seal.

B. Sumps and Ejectors

1. Connect to standby power. Provide high water limit alarm locally and at ASU BAS.
2. Sumps and ejectors shall vent through roof separate from the building vent.
3. Use ball type check valve for submersible pumps. Flapper or disc type are not to be used unless sewarge rated.

C. Hose Bibbs

1. Provide Hose Bibbs as required per code and one (1) at all loading docks.

22 40 00 - Plumbing Fixtures

Part 1 - Products

A. Electric Drinking Fountains

1. Fountains shall have a stainless steel bowl and drain with flow-restricting bubbler and push-bar operation. Fountains shall include water bottle filler with use counter.
2. Provide with hermetic compressor utilizing non-ozone depleting refrigerant. Front panel shall be removable and unit shall be constructed so that the refrigeration unit can be removed without removing the cooler from the wall. Remote compressors shall not be used.

B. Urinals

1. Low flow urinals, 0.125 gpf (no waterless urinals).

C. Wall Hung Water Closets

1. Wall hung water closets shall be provided with heavy duty carriers rated for minimum 750-1000 lbs.

D. Emergency Eyewashes/Showers

1. A combination emergency eyewash/shower assembly is the preferred fixture type. Deck mounted eyewash fixtures are not allowed.
2. Eyewashes/ Showers are not required to have a local alarm.

Part 2 - Execution

A. Electric Drinking Fountains

1. All drinking fountains shall be barrier free and installed per ADAAG.
2. New construction and major renovations shall provide a minimum of two drinking fountains per floor.

B. Emergency Eyewashes/Showers

1. *Equipment does not need a mixing water valve if the existing supply water meets the tepid water requirement (60-100°F).*

22 60 00 - Common Utilities for Laboratory Facilities

Part 1 - Products

General

The guidelines below are intended for building above ground applications only. Each application shall be specifically addressed to identify purity requirements that may exceed the materials below. Consult

Environmental Health and Safety (EHS) and ASU Project Manager (PM) regarding piping requirements for hazardous or corrosive media.

A. Compressed Air, Nitrogen and Carbon Dioxide

1. Copper
    - a. Pipe: Type L, hard drawn, cleaned and capped, ASTM B280.
    - b. Joints: Brazed, AWS A5.8, BCuP-5.
    - c. Fittings: Wrought copper, ANSI B16.22, cleaned and bagged.
2. Isolation Valves (3” and smaller)
    - a. Full port, 3-piece, bronze body, stainless steel ball and stem, oxygen cleaned and bagged.

B. Vacuum

1. Copper:
    - a. Pipe: Type L, hard drawn, ASTM B88.
    - b. Joints: Lead free solder, ASTM B32.
    - c. Fittings: Cast copper, ANSI B16.23; wrought copper, ANSI B16.29.
2. Isolation Valves (3” and smaller)
    - a. Ball valve, 3-piece, bronze body, full port, stainless steel ball and stem.
3. Isolation Valves (4” to 6”)
    - a. Butterfly valve, ductile iron, lug type, stainless steel disc and stem.

C. RO/DI Water

1. For use with maximum 100PSIG @ 80F operating pressure and temperature limits and sizes indicated.
    - a. CPVC (6” and smaller).
    - b. Schedule 80, ASTM D-1784, ASTM F441.
    - c. Fittings/Joints: Socket pattern with solvent cemented joints suitable for use on potable water, ASTM F439-19.
    - d. Valves shall be same material and manufacturer as piping.
    - e. Pipe and Fittings shall meet Flame Spread Index of 25 and a maximum Smoke Developed Index of 50 when tested in accordance with ASTM E 84 and UL 723.

D. Air Compressors

1. Main building compressors shall be duplex (or triplex) and operate in a lead-lag fashion.
2. Compressors shall be oil free.
3. Water conservation options shall be considered.

E. Vacuum Pumps

1. Main building pumps shall be duplex (or triplex) and operate in a lead-lag fashion.
2. Oil ring pumps are preferred.
3. Water conservation options are preferred.

Part 2 - Execution

General

Provide isolation valves at each floor, at each laboratory and at each piece of equipment. Laboratory isolation valves shall be located outside the laboratory proper.

Branch connections shall be connected made at the top of the main for all laboratory gas, vacuum and water piping.

A. Vacuum

1. Provide line sized cleanout at end of mains for flushing.
2. Size and arrange exhaust stack to prevent moisture and back-pressure form entering pump. Provide valved drip leg at base of exhaust stacks.

B. RO/DI

1. Provide system with self-closing valves and faucets.
2. Route piping in a loop configuration to minimize dead legs. Dead legs over 12 inches are not allowed.

DIVISION 23 - HEATING, VENTILATING, AND AIR CONDITIONING (HVAC)

23 05 93 - Testing, Adjusting, and Balancing For HVAC

General

All work shall be performed by an independent third party test and balance Contractor contracted by the Owner or the Owner’s representative and under the direction of a Certified Test and Balance Engineer. The test and balance Contractor shall not be selected by the general contractor or a sub-contractor to the General Contractor or any of its sub-contractors. The Contractor's technicians shall meet the qualifications of the Contractor's certification agency. TAB firm shall be certified by either AABC or NEBB with a minimum of five years’ experience.

Perform testing and balancing procedures on each system according to the procedures contained in AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems", NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems", or SMACNA's "HVAC Systems - Testing, Adjusting, and Balancing" and this Section.

Use standard forms from AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems" or NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems" whenever possible. Five (5) copies of the test and balance report are required and shall be submitted to the Owner for approval. In addition, a copy of all approved test and balance reports shall be included in each copy of the Maintenance Manual.

TAB work shall not proceed until all assigned personnel have been approved by Architect/Engineer. Coordinate each phase of TAB work with overall project schedule. Fieldwork must be completed before occupancy. Certificate of Substantial Completion shall not be issued until after Final Report is accepted by Architect/Engineer.

Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary to allow adequate performance of procedures. After testing and balancing, close probe holes and patch insulation with new materials identical to those removed. Restore vapor barrier and finish according to project specifications.

Mark equipment and balancing device settings with paint or other suitable, permanent identification material, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, to show final settings and to allow the settings to be restored.

The balancing agency shall not instructor direct the mechanical contractor in any of the work. Any proposed changes or revision in the work shall be submitted to the Design Professional (DP) in writing. The DP shall, in coordination with his engineer, process the proposal as appropriate.

Tolerances

A. Unless project specifications set tighter tolerances, HVAC system airflow and water flow rate tolerances shall not exceed the following:

  1. Supply, Return, and Exhaust Fans and Equipment with Fans: Zero to plus 10 percent.
  2. Air Outlets and Inlets: minus 5 percent to plus 10 percent (ensure room pressure requirements are maintained).
  3. Heating-Water Flow Rate: 0 to minus 10 percent.
  4. Cooling-Water Flow Rate: 0 to minus 5 percent.

Pre-Balance Report

A. If renovation is anticipated to affect more than 10 percent of an existing systems capacity, a system pre-balance report shall be performed prior to renovation to verify that sufficient system capacity is available for the proposed renovation, and that the renovation will not adversely affect non-renovated areas.

Final Report

A. Final Report Contents

  1. In addition to certified field report data, include the following:
    a. Pump curves.
    b. Fan curves.
    c. Manufacturers' test data.
    d. Field test reports prepared by system and equipment installers.
    e. Other information relative to equipment performance, but do not include Shop Drawings and Product Data.

B. General Report Data

  1. In addition to form titles and entries, include the following data in the final report, as applicable.
    a. Title page.
    b. Name and address of TAB firm.
    c. Project name.
    d. Project location.
    e. Architect's name and address.
    f. Engineer's name and address.
    g. Contractor's name and address.
    h. Report date.
    i. Signature of TAB firm who certifies the report.
    j. Table of Contents with the total number of pages defined for each section of the report.

Number each page in the report.

- k. Summary of contents including the following:
  - i. Indicated versus final performance.
  - ii. Notable characteristics of systems.
  - iii. Description of system operation sequence if it varies from the Contract Documents.
- l. Nomenclature sheets for each item of equipment.
- m. Data for terminal units, including manufacturer, type size, and fittings.
- n. Notes to explain why certain final data in the body of reports varies from indicated values.

C. System Diagrams:

1. Include schematic layouts of air and hydronic distribution systems. Present each system with single-line diagram and include the following:

   - a. Quantities of outside, supply, return, and exhaust airflows.
   - b. Water and steam flow rates.
   - c. Duct, outlet, and inlet sizes.
   - d. Pipe and valve sizes and locations.
   - e. Terminal units.
   - f. Balancing stations.
   - g. Position of balancing devices.
2. Include the following applicable information in the test reports for these common systems. Refer to project specifications for additional requirements.

D. Air-Handling Unit:

1. Unit Data
   - a. Unit identification.
   - b. Location.
   - c. Make and type.
   - d. Model number and unit size.
   - e. Manufacturer's serial number.
   - f. Unit arrangement and class.
   - g. Discharge arrangement.
   - h. Sheave make, size in inches, and bore.
   - i. Sheave dimensions, center-to-center, and amount of adjustments in inches.
   - j. Number of belts, make, and size.
   - k. Number of filters, type, and size.
2. Motor Data
   - a. Make and frame type and size.
   - b. Horsepower and rpm.
   - c. Volts, phase, and hertz.

d. Full-load amperage and service factor.
e. Sheave make, size in inches, and bore.
f. Sheave dimensions, center-to-center, and amount of adjustments in inches.

3. Test Data (Indicated and Actual Values)
    a. Total airflow rate in cfm.
    b. Total system static pressure in inches wg.
    c. Fan rpm.
    d. Discharge static pressure in inches wg.
    e. Filter static-pressure differential in inches wg.
    f. Individual coil static-pressure differential in inches wg.
    g. Outside airflow in cfm.
    h. Return airflow in cfm.
    i. Individual damper positions.

E. Apparatus-Coil

1. Coil Data
    a. System identification.
    b. Location.
    c. Coil type.
    d. Number of rows.
    e. Fin spacing in fins per inch o.c.
    f. Make and model number.
    g. Face area in sq. ft.
    h. Tube size in NPS.
    i. Tube and fin materials.
    j. Circuiting arrangement.
2. Test Data (Indicated and Actual Values).
    a. Airflow rate in cfm.
    b. Average face velocity in fpm.
    c. Air pressure drop in inches wg.
    d. Outside-air, wet- and dry-bulb temperatures in deg F.
    e. Return-air, wet- and dry-bulb temperatures in deg F.
    f. Entering-air, wet- and dry-bulb temperatures in deg F.
    g. Leaving-air, wet- and dry-bulb temperatures in deg F.
    h. Water flow rate in gpm.
    i. Water pressure differential in feet of head or psig.
    j. Entering-water temperature in deg F.

        - k. Leaving-water temperature in deg F.
        - l. Refrigerant expansion valve and refrigerant types.
        - m. Refrigerant suction pressure in psig.
        - n. Refrigerant suction temperature in deg F.
        - o. Inlet steam pressure in psig.

F. Gas- and Oil-Fired Heat Apparatus:

1. Unit Data
    - a. System identification.
    - b. Location.
    - c. Make and type.
    - d. Model number and unit size.
    - e. Manufacturer's serial number.
    - f. Fuel type in input data.
    - g. Output capacity in Btuh.
    - h. Ignition type.
    - i. Burner-control types.
    - j. Motor horsepower and rpm.
    - k. Motor volts, phase, and hertz.
    - l. Motor full-load amperage and service factor.
    - m. Sheave make, size in inches, and bore.
    - n. Sheave dimensions, center-to-center, and amount of adjustments in inches.
2. Test Data (Indicated and Actual Values)
    - a. Total airflow rate in cfm.
    - b. Entering-air temperature in deg F.
    - c. Leaving-air temperature in deg F.
    - d. Air temperature differential in deg F.
    - e. Entering-air static pressure in inches wg.
    - f. Leaving-air static pressure in inches wg.
    - g. Air static-pressure differential in inches wg.
    - h. Low-fire fuel input in Btuh.
    - i. High-fire fuel input in Btuh.
    - j. Manifold pressure in psig.
    - k. High-temperature-limit setting in deg F.
    - l. Operating set point in Btuh.
    - m. Motor voltage at each connection.
    - n. Motor amperage for each phase.

- o. Heating value of fuel in Btuh.

G. Electric-Coil:

1. For electric furnaces, duct coils, and electric coils installed in central-station air-handling units.
    - a. Unit Data:
        - i. System identification.
        - ii. Location.
        - iii. Coil identification.
        - iv. Capacity in Btuh.
        - v. Number of stages.
        - vi. Connected volts, phase, and hertz.
        - vii. Rated amperage.
        - viii. Airflow rate in cfm.
        - ix. Face area in sq. ft.
        - x. Minimum face velocity in fpm.
2. Test Data (Indicated and Actual Values):
    - b. Heat output in Btuh.
    - c. Airflow rate in cfm.
    - d. Air velocity in fpm.
    - e. Entering-air temperature in deg F.
    - f. Leaving-air temperature in deg F.
    - g. Voltage at each connection.
    - h. Amperage for each phase.

H. Fans:

1. For supply, return, and exhaust fans.
    - a. Fan Data
        - i. System identification.
        - ii. Location.
        - iii. Make and type.
        - iv. Model number and size.
        - v. Manufacturer's serial number.
        - vi. Arrangement and class.
        - vii. Sheave make, size in inches, and bore.
        - viii. Sheave dimensions, center-to-center, and amount of adjustments in inches.
    - b. Motor Data
        - i. Make and frame type and size.
        - ii. Horsepower and rpm.

      - iii. Volts, phase, and hertz.
      - iv. Full-load amperage and service factor.
      - v. Sheave make, size in inches, and bore.
      - vi. Sheave dimensions, center-to-center, and amount of adjustments in inches.
      - vii. Number of belts, make, and size.
    - c. Test Data (Indicated and Actual Values)
      - i. Total airflow rate in cfm.
      - ii. Total system static pressure in inches wg.
      - iii. Fan rpm.
      - iv. Discharge static pressure in inches wg.
      - v. Suction static pressure in inches wg.

I. Round, Flat-Oval, and Rectangular Duct Traverse

- 1. Include a diagram with a grid representing the duct cross-section.
  - a. Report Data
    - i. System and air-handling unit number.
    - ii. Location and zone.
    - iii. Traverse air temperature in deg F.
    - iv. Duct static pressure in inches wg.
    - v. Duct size in inches.
    - vi. Duct area in sq. ft.
    - vii. Indicated airflow rate in cfm.
    - viii. Indicated velocity in fpm.
    - ix. Actual airflow rate in cfm.
    - x. Actual average velocity in fpm.
    - xi. Barometric pressure in psig.

J. Air-Terminal-Device:

- 1. Unit Data:
  - a. System and air-handling unit identification.
  - b. Location and zone.
  - c. Test apparatus used.
  - d. Area served.
  - e. Air-terminal-device make.
  - f. Air-terminal-device number from system diagram.
  - g. Air-terminal-device type and model number.
  - h. Air-terminal-device size.
  - i. Air-terminal-device effective area in sq. ft.

2. Test Data (Indicated and Actual Values)
    a. Airflow rate in cfm.
    b. Air velocity in fpm.
    c. Preliminary airflow rate as needed in cfm.
    d. Preliminary velocity as needed in fpm.
    e. Final airflow rate in cfm.
    f. Final velocity in fpm.
    g. Space temperature in deg F.

K. System-Coil

1. For reheat coils and water coils of terminal units.
    a. Unit Data
        i. System and air-handling unit identification.
        ii. Location and zone.
        iii. Room or riser served.
        iv. Coil make and size.
        v. Flowmeter type.
    b. Test Data (Indicated and Actual Values)
        i. Airflow rate in cfm.
        ii. Entering-water temperature in deg F.
        iii. Leaving-water temperature in deg F.
        iv. Water pressure drop in feet of head or psig.
        v. Entering-air temperature in deg F.
        vi. Leaving-air temperature in deg F.

L. Packaged Chiller

1. Unit Data
    a. Unit identification.
    b. Make and model number.
    c. Manufacturer's serial number.
    d. Refrigerant type and capacity in gal.
    e. Starter type and size.
    f. Starter thermal protection size.
    g. Compressor make and model number.
    h. Compressor manufacturer's serial number.
2. Water-Cooled Condenser Test Data (Indicated and Actual Values)
    a. Refrigerant pressure in psig.

- b. Refrigerant temperature in deg F.
- c. Entering-water temperature in deg F.
- d. Leaving-water temperature in deg F.
- e. Entering-water pressure in feet of head or psig.
- f. Water pressure differential in feet of head or psig.

3. Air-Cooled Condenser Test Data (Indicated and Actual Values)
    - a. Refrigerant pressure in psig.
    - b. Refrigerant temperature in deg F.
    - c. Entering- and leaving-air temperature in deg F.
4. Evaporator Test Reports (Indicated and Actual Values)
    - a. Refrigerant pressure in psig.
    - b. Refrigerant temperature in deg F.
    - c. Entering-water temperature in deg F.
    - d. Leaving-water temperature in deg F.
    - e. Entering-water pressure in feet of head or psig.
    - f. Water pressure differential in feet of head or psig.
5. Compressor Test Data (Indicated and Actual Values):
    - a. Suction pressure in psig (kPa).
    - b. Suction temperature in deg F.
    - c. Discharge pressure in psig.
    - d. Discharge temperature in deg F.
    - e. Oil pressure in psig.
    - f. Oil temperature in deg F.
    - g. Voltage at each connection.
    - h. Amperage for each phase.
    - i. Kilowatt input.
    - j. Crankcase heater kilowatt.
    - k. Chilled-water control set point in deg F.
    - l. Condenser-water control set point in deg F.
    - m. Refrigerant low-pressure-cutoff set point in psig.
    - *n.* Refrigerant high-pressure-cutoff set point in psig.
6. Refrigerant Test Data (Indicated and Actual Values)
    - a. Oil level.
    - b. Refrigerant level.
    - c. Relief valve setting in psig.
    - d. Unloader set points in psig.

e. Percentage of cylinders unloaded.

f. Bearing temperatures in deg F.

g. Vane position.

h. Low-temperature-cutoff set point in deg F.

M. Compressor and Condenser

1. For refrigerant side of unitary systems, stand-alone refrigerant compressors, air-cooled condensing units, or water-cooled condensing units:

a. Unit Data

  i. Unit Identification

  ii. Location

  iii. Unit make and model number

  iv. Compressor make

  v. Compressor model and serial numbers

  vi. Refrigerant weight in lb.

  vii. Low ambient temperature cutoff in deg F

b. Test Data (Indicated and Actual Values)

  i. Inlet-duct static pressure in inches wg

  ii. Outlet-duct static pressure in inches wg

c. Entering-air, dry-bulb temperature in deg F

d. Leaving-air, dry-bulb temperature in deg F

e. Condenser entering water temperature in deg F

f. Condenser leaving water temperature in deg F

g. Condenser water temperature differential in deg F

h. Condenser entering water pressure in feet of head or psig

i. Condenser leaving water pressure in feet of head or psig

j. Condenser water pressure differential in feet of head or psig

k. Control settings

l. Unloader set points

m. Low-pressure-cutout set point in psig

n. High-pressure-cutout set point in psig.

o. Suction pressure in psig.

p. Suction pressure in psig.

q. Suction temperature in deg F.

r. Condenser refrigerant pressure in psig.

s. Condenser refrigerant temperature in deg F.

t. Oil pressure in psig.

u. Oil temperature in deg F.

- v. Voltage at each connection.
- w. Amperage for each phase.
- x. Kilowatt input.
- y. Crankcase heater kilowatt.
- z. Number of fans.
- aa. Condenser fan rpm.
- bb. Condenser fan airflow rate in cfm.
- cc. Condenser fan motor make, frame size, rpm, and horsepower.
- dd. Condenser fan motor voltage at each connection.
- ee. Condenser fan motor amperage for each phase.

N. Cooling Tower or Condenser

1. Unit Data
   - a. Unit identification.
   - b. Make and type.
   - c. Model and serial numbers.
   - d. Nominal cooling capacity in tons.
   - e. Refrigerant type and weight in lb.
   - f. Water-treatment chemical feeder and chemical.
   - g. Number and type of fans.
   - h. Fan motor make, frame size, rpm, and horsepower.
   - i. Fan motor voltage at each connection.
   - j. Sheave make, size in inches, and bore.
   - k. Sheave dimensions, center-to-center, and amount of adjustments in inches.
   - l. Number of belts, make, and size.
   - m. Pump make and model number.
   - n. Pump manufacturer's serial number.
   - o. Pump motor make and frame size.
   - p. Pump motor horsepower and rpm.
2. Pump Test Data for Recirculating Pumps in Evaporative Coolers. Use Pump Test report for Cooling Towers (Indicated and Actual Values):
   - a. Voltage at each connection.
   - b. Amperage for each phase.
   - c. Water flow rate in gpm.
3. Water Test Data (Indicated and Actual Values).
   - a. Entering-water temperature in deg F.
   - b. Leaving-water temperature in deg F.

- c. Water temperature differential in deg F.
- d. Entering-water pressure in feet of head or psig.
- e. Leaving-water pressure in feet of head or psig.
- f. Water pressure differential in feet of head or psig.
- g. Water flow rate in gpm.
- h. Bleed water flow rate in gpm.

4. Air Data (Indicated and Actual Values)
   - a. Duct airflow rate in cfm.
   - b. Inlet-duct static pressure in inches wg.
   - c. Outlet-duct static pressure in inches wg.
   - d. Average entering-air, wet-bulb temperature in deg F.
   - e. Average leaving-air, wet-bulb temperature in deg F.
   - f. Ambient wet-bulb temperature in deg F.

O. Heat-Exchanger/Converter

1. For steam and hot-water heat exchangers and converters.
   - a. Unit Data.
   - b. Unit identification.
   - c. Location.
   - d. Service.
   - e. Make and type.
   - f. Model and serial numbers.
   - g. Ratings.
2. Steam Test Data (Indicated and Actual Values)
   - a. Inlet pressure in psig.
   - b. Condensate flow rate in lb/h.
   - c. Primary Water Test Data (Indicated and Actual Values).
   - d. Entering-water temperature in deg F.
   - e. Leaving-water temperature in deg F.
   - f. Entering-water pressure in feet of head or psig.
   - g. Water pressure differential in feet of head or psig.
   - h. Water flow rate in gpm.
3. Secondary Water Test Data (Indicated and Actual Values)
   - a. Entering-water temperature in deg F.
   - b. Leaving-water temperature in deg F.
   - c. Entering-water pressure in feet of head or psig.
   - d. Water pressure differential in feet of head or psig.

e. Water flow rate in gpm.

P. Pump Test:

1. Calculate impeller size by plotting the shutoff head on pump curves.
    a. Unit Data:
        i. Unit identification.
        ii. Location.
        iii. Service.
        iv. Make and size.
        v. Model and serial numbers.
        vi. Water flow rate in gpm.
        vii. Water pressure differential in feet of head or psig.
        viii. Required net positive suction head in feet of head or psig.
        ix. Pump rpm.
        x. Impeller diameter in inches.
        xi. Motor make and frame size.
        xii. Motor horsepower and rpm.
        xiii. Voltage at each connection.
        xiv. Amperage for each phase.
        xv. Full-load amperage and service factor.
        xvi. Seal type.
    b. Test Data (Indicated and Actual Values)
        i. Static head in feet of head or psig.
        ii. Pump shutoff pressure in feet of head or psig.
        iii. Actual impeller size in inches.
        iv. Full-open flow rate in gpm.
        v. Full-open pressure in feet of head or psig.
        vi. Final discharge pressure in feet of head or psig.
        vii. Final suction pressure in feet of head or psig.
        viii. Final total pressure in feet of head or psig.
        ix. Final water flow rate in gpm.
        x. Voltage at each connection.
        xi. Amperage for each phase

Q. Boiler:

1. Unit Data:
    a. Unit identification location.
    b. Service.

  - c. Make and type.
  - d. Model and serial numbers.
  - e. Fuel type and input in Btuh.
  - f. Number of passes.Ignition type.
  - g. Burner-control types.
  - h. Voltage at each connection.
  - i. Amperage for each phase.
2. Test Data (Indicated and Actual Values)
  - a. Operating pressure in psig.
  - b. Operating temperature in deg F.
  - c. Entering-water temperature in deg F.
  - d. Leaving-water temperature in deg F.
  - e. Number of safety valves and sizes in NPS.
  - f. Safety valve settings in psig.
  - g. High-limit setting in psig.
  - h. Operating-control setting.
  - i. High-fire set point.
  - j. Low-fire set point.
  - k. Voltage at each connection.
  - l. Amperage for each phase.
  - m. Draft fan voltage at each connection.
  - n. Draft fan amperage for each phase.
  - o. Manifold pressure in psig.

Inspections

A. **Initial Inspection**

1. After testing and balancing are complete, operate each system and randomly check measurements to verify that the system is operating according to the final test and balance readings documented in the Final Report.

B. **Final Inspection**

1. After initial inspection is complete and evidence by random checks verifies that testing and balancing is complete and accurately documented in the final report, request that a final inspection be made by Owner and Engineer.
2. TAB firm test and balance engineer shall conduct the inspection in the presence of Owner and Engineer.
3. Engineer shall randomly select measurements documented in the final report to be rechecked. The rechecking shall be limited to 10 percent of the total measurements recorded for each system.
4. If the rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as FAILED.

5. If the number of FAILED measurements is greater than 10 percent of the total measurements checked during the final inspection, the testing and balancing shall be considered incomplete and the Final Report shall be rejected.

C. In the event the Final Report is rejected, the TAB firm shall recheck all measurements and make necessary adjustments. The TAB firm shall revise the final report and document balancing device settings to reflect all changes. The TAB firm shall resubmit the report and request another final inspection. Additional work incurred from FAILED test and balance reports shall be at no additional cost to the Owner.

D. **Opposite Season Test**

1. 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.

23 11 23 - Natural Gas

Part 1 - Products

A. ***Below Ground***

1. Coordinate with local utility.

B. ***Above ground***

1. Carbon Steel
    - a. Pipe: Carbon steel, Schedule 40, Grade B. Use A53 below 5 psig and A106 above 5 psig.
    - b. Joints/Fittings: Shall be as required of pressure and size per NFPA and local codes.

C. ***Valves***

1. Isolation valves.
    - a. Ball valve, bronze body, full port, chrome plated brass ball, blowout proof stem, TFE seat, quarter turn.
    - b. Ball valve, carbon steel body, stainless steel ball and stem, PTFE seats, quarter turn.

Part 2 - Execution

General

Avoid routing any gas piping under slab beneath buildings.

Gas piping shall not to be used as a ground.

Provide dirt legs, drain tees and plugs at equipment and appliances.

Branch connections shall be made at the top or side of the main.

23 21 13 - Hydronic Piping

Revised 2017

Part 1 - Products

A. **Heating Hot Water (<200F) and Chilled Water Piping**

1. Building
    - a. Copper (2” and smaller)
        - i. Pipe: Type L, hard drawn, ASTM B88.
        - ii. Joints: Lead free solder, ASTM B32.
        - iii. Fittings: Wrought copper, ANSI B16.22.
    - b. Carbon Steel (2-1/2” and larger)
        - i. Pipe: Grade B, Type S (preferred) or E, standard weight, ASTM A53.
        - ii. Joints: Butt welded.
        - iii. Fittings: Carbon steel, standard weight, seamless, ASTM A234 WPB, ANSI B16.9.
2. Underground Direct Buried Campus Main Distribution
    - a. Pre-insulated pipe system with pipe as described above for Building and Campus Main

Distribution with polyurethane foam insulation and fiberglass reinforced polyester resin jacket.

b. Pre-Insulated High Density Polyethylene (200 psi – PE 4710 DR11) pipe and fittings fusion welded with polyurethane foam insulation. HDPE jacket material minimum 250 mils thickness meeting ASTM D-1248

B. **Valves**

1. Isolation Valves
    a. Ball valve, bronze body, full port, stainless steel ball and stem, Teflon seat, quarter turn.
    b. Butterfly valve, cast or ductile iron body, lug type, stainless steel stem, aluminum-bronze disc, EPDM seat, quarter turn.
    c. Gate valves shall not be used unless pre-approved by ASU.
2. Balancing Valves
    a. Globe valve, dezincification resistant brass or bronze, metering ports with position display, multiple turn with memory stop. Quarter turn valves shall not be used.
    b. Butterfly valve with venturi flow meter, ductile iron body, lug type, aluminum bronze disc, EPDM seat, multiple turn with memory stop. Quarter turn valves shall not be used.

Part 2 - Execution

A. **Piping**

1. For changes in horizontal pipe sizes, use eccentric reducer fitting installed with level side up. Concentric fittings may be used in vertical applications.
2. Install branch connections to mains using tee fittings in main pipe, with the takeoff coming out the bottom of the main pipe. For up-feed risers, install the takeoff coming out the top of the main pipe.
3. Minimum pipe size shall be ¾”.

B. **Valves**

1. Provide separate balancing, check and isolation valves at the discharge of hydronic pumps. Triple duty valves shall not be used. Balancing valves at pump discharge shall be sized for a maximum pressure drop of five (5) feet at design flow rate (full open) and allow a pressure of 25 feet when throttled. Balancing valves on pumps with VFD’s are not desired, however some level of flow measurement at each pump shall be implemented. Check valves shall be located on the equipment side of the isolation valve.
2. Install shutoff duty valves at each branch connection to supply mains and at supply connection to each piece of equipment.
3. Install balancing valves in the return water line of each heating or cooling element and elsewhere as required to facilitate system balancing.
4. Install relief valves as required by code. Install relief-valve discharge piping, without valves, to floor sink.

C. **Specialties**

1. Bypass chemical feeders shall be installed in an upright position with top of funnel not more than 48 inches above floor. Install feeder in bypass line, off main, using globe valves on each side of feeder and in the main between bypass connections. Pipe drain, with ball valve, to nearest floor sink.

2. Install expansion tanks on floor. Vent and purge air from hydronic system, and ensure tank is properly charged with air to suit system design requirements.
3. Install system air separators at the lowest pressure, highest temperature point in the system.

D. **Terminal Equipment Connections**

1. Size for supply and return piping connections shall not be less than equipment connections.
2. Install control valves in accessible locations close to connected equipment. Control valves shall be installed in the return piping.
3. Install ports for pressure and temperature gauges at coil inlet connections.

   Install balancing valve at each terminal device. Balancing valve shall be installed in the return piping downstream of the control valve.

23 21 23 - Hydronic Pumps

Part 1 - Products

Section Left Blank Intentionally.

Part 2 - Execution

General

Install pumps in accordance with manufacturer’s instructions. Confirm materials of construction against system operating conditions with the manufacturer.

In general, use flat characteristic pumps for closed-loop, variable volume systems. Use steep characteristic pumps for open loop, constant volume systems.

Preferred selection of pumps is in the range of 85% to 105% of flow at the best efficiency point. Select pumps slightly to the left of the best efficiency point and such that larger impellers may be installed for future considerations.

Set base-mounted pumps on concrete bases, or concrete inertia base, level and bolt down prior to grouting. Fill entire base with non-shrinking grout. Use end caps during grouting to prevent overflow when end caps are not integral with base plates.

Impellers shall be trimmed or replaced if it is shown that the actual system curve produces excessive flow at full load than at the designed system curve.

Motors shall be selected to be non-overloading at the specified impeller size and maximum flow. Use

double suction horizontal or vertical split case pumps for high-capacity applications.

Use mechanical seals. Packing type not allowed. Bearings shall be heavy-duty regreasable ball bearings.

Provide necessary concentric reducers/increasers for vertical piping at pump connection and eccentric reducers/increasers for horizontal piping at pump connection. Install eccentric reducers/increasers with top of pipe level. Valves and piping specialties shall be full line size.

A. **Inline Centrifugal (May be used for applications up to 5 hp).**

1. Mount pumps with motors mounted vertically.
2. Pumps shall be pipeline mounted without flexible connections.

B. **End Suction Centrifugal**

1. Use flexible/split coupled pumps whenever possible. Do not use close coupled pumps over 20 hp. Design shall allow for servicing of impeller and bearing assembly without disturbing piping, motor or requiring shaft realignment.

2. Align flexible coupled pumps after base grouting. Align in all four planes. After alignment, pin pump and motor to base.
3. Set close coupled pumps on concrete bases using flush type anchors and cap screws.

23 22 13 – Steam and Condensate Heating Piping

(Excludes Clean Steam)

Part 1 - Products

A. **Steam Pipe - 0 to 100 PSIG**

1. Building Distribution
    - a. Carbon Steel (2” and smaller)
        - i. Pipe: Grade B, Type S (seamless preferred) or E (electrically resistance welded), standard weight, ASTM A53.
        - ii. Joints: Screwed NPT.
        - iii. Fittings: Malleable iron, ANSI B16.3.
2. Carbon Steel (2-1/2” and larger)
    - i. Pipe: Grade B, Type S (seamless preferred) or E (electrically resistance welded), standard weight, ASTM A53.
    - ii. Joints: Butt welded.
    - iii. Fittings: Wrought Carbon steel, standard weight, high temperature service, ASTM A234 WPB, ANSI B16.9.
3. Campus Main Distribution:
    - a. Carbon Steel (2” and smaller).
        - i. Pipe: Grade B, extra strong (“XS” or schedule 80), ASTM A106.
        - ii. Joints: Socket weld.
        - iii. Fittings: Forged carbon steel, #3000 ASTM A105 Grade II, ANSI B16.11.
    - b. Carbon Steel (2-1/2” and larger).
        - i. Pipe: Grade B, extra strong (“XS” or schedule 80), ASTM A106.
        - ii. Joints: Butt welded.
        - iii. Fittings: Wrought Carbon steel, extra strong, seamless, ASTM A234 WPB, ANSI B16.9.
    - c. Direct buried: Pre-insulated double containment piping with carrier pipe as described above, contained within a drainable, dryable, pressure tested, Class A, insulated steel conduit.

B. **Condensate Pipe - 0 to 100 PSIG, Pumped Condensate**

1. Building Distribution.
    - a. Carbon Steel (2” and smaller).
        - i. Pipe: Grade B,”XS” extra strong or schedule 80, ASTM A106.
        - ii. Joints: Screwed NPT.
        - iii. Fittings: Malleable iron, ANSI B16.3.

- b. Carbon Steel (2-1/2” and larger).
  - i. Pipe: Grade B, “XS” extra strong or schedule 80, ASTM A106.
  - ii. Joints: Butt welded.
  - iii. Fittings: Carbon steel, standard weight, ASTM A234 WPB, ANSI B16.9.

2. Campus Main Distribution
   - a. Carbon Steel (2” and smaller).
     - i. Pipe: Grade B, “XS” extra strong or schedule 80, ASTM A106.
     - ii. Joints: Socket weld.
     - iii. Fittings: Forged carbon steel, 3000# ASTM A105 Grade II, ANSI B16.11.
   - b. Carbon Steel (2-1/2” and larger).
     - i. Pipe: Grade B, “XS” extra strong or schedule 80, ASTM A106.
     - ii. Joints: Butt welded.
     - iii. Fittings: Carbon steel, “XS” extra strong or schedule 80, ASTM A234 WPB, ANSI B16.9.
   - c. Direct buried: Pre-insulated double containment piping with carrier pipe as described above, contained within a drainable, dryable, pressure tested, Class A, insulated steel conduit.

C. **Valves**

1. Isolation Valves
   - a. Condensate
     - i. Ball valve, bronze body, full port, stainless steel ball and stem, blowout proof stem, RTFE seat, quarter turn. (1/2” thru 2”).
     - ii. Gate valve, forged carbon steel, 800# ASTM A-105, 12-13% chrome, OSandY bolted bonnet, renewable seat, solid wedge disc. (1/2” thru 2”).
     - iii. Gate valve, cast carbon steel, 150# ASTM A-216 WCB, 13% chrome to hard facing, OSandY bolted bonnet, flexible disc. (2-1/2” thru 24”).
   - b. Steam
     - i. Gate valve, forged carbon steel, 800# ASTM A-105, 12-13% chrome, OSandY bolted bonnet, renewable seat, solid wedge disc. (1/2” thru 2”).
     - ii. Gate valve, cast carbon steel, 150# ASTM A-216 WCB, 13% chrome to hard facing, OSandY bolted bonnet, flexible disc. (2-1/2” thru 24”).
2. Throttling Valves (steam)
   - a. Globe valve, forged carbon steel, 800# ASTM A-105, 12-13% chrome, OSandY bolted bonnet, loose seat, integral hard faced seat. (1/2” thru 2”).
   - b. Globe valve, cast carbon steel, 150# ASTM A-216 WCB, 13% chrome to hard facing, OSandY bolted bonnet, renewable seat ring and disc. (2-1/2” thru 6”).
3. Check Valves at:
   - a. Condensate traps:
     - i. Stainless steel body, stainless steel trim, Inconel spring, TFE seat. (1/2” thru 2”).
     - ii. Cast steel body, 13% chrome to hard facing, bolted bonnet, renewable disc swing

type. (2-1/2” thru 24”).

- iii. Condensate pump discharge.
- iv. Stainless steel body, stainless steel trim and spring, spring loaded type. 1/2” thru 2”).
- v. Cast iron, stainless steel trim, spring loaded wafer type. (2-1/2” thru 24”).

Part 2 - Execution

A. Piping

- a. For changes in horizontal pipe sizes, use eccentric reducer fitting installed with level side down. Concentric fittings may be used in vertical applications.
- b. Install steam branch connections to steam mains using 45-degree fittings in main pipe, with the takeoff coming out the top of the main pipe. 45-degree fitting shall be in the direction of flow. Use of 90-degree tee fittings is permissible if 45-degree fittings are impractical. If length of branch takeoff is less than 10 feet, pitch branch line down toward mains at a minimum 0.4 percent grade.
- c. Install condensate branch connections to condensate mains using 45-degree fittings in main pipe with takeoff coming out of the top of the main in the direction. 45-degree fitting shall be in the direction of flow. Use of 90-degree tee fittings is permissible of 45-degree fittings are impractical.
- d. Install condensate connection from steam mains using bottom connection to the main.
- e. Install non-seamless pipe with seam at the top of the pipe.
- f. Install drip legs at low points and natural drainage points such as ends of mains, bottoms of risers, and ahead of pressure regulators, control valves, isolation valves, pipe bends, and expansion joints.
- g. On straight runs with no natural drainage points, install drip legs at intervals not exceeding 300 feet where pipe is pitched down in the direction of steam flow and a maximum of 150 feet where pipe is pitched up in direction of steam flow.
- h. Diameter of drip legs at vertical risers should meet the minimum **steam** trap manufacturer requirements and industry best practice. Size drip legs at other locations same diameter as main. In steam mains NPS 6 and larger, dirt leg size can be reduced, but to no less than NPS 4. Drip legs 22 shall be no less than 12 inches in length if supervised and no less than 28 inches if unsupervised.
- i. Install gate valve at bottom of drip legs, dirt pockets, and strainer blowdowns to allow removal of dirt and scale.
- j. Install steam traps close to drip legs.
- k. *Steam Line Drainage:* For steam pipes in tunnels sloped down in the direction of steam flow; 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 inches per 100 feet. Steam lines may be peaked with lines pitched as above. Final pipe elevations must be recorded on the as-built drawings.
- l. *Design Velocities:* Steam velocity preference is to minimize noise and erosion. Common practices shall be followed (4,000 to 8,000 fpm). When necessary, elevated velocities 10,000 fpm and over must have prior written approval. Condensate velocity preference shall follow good design practice as may be found in ASHRAE Handbook – HVAC Systems and Equipment “Steam Systems”, Fundamentals “Piping”.

B. **Valves**

1. Install a check valve at the steam condensate trap discharge if condensate is to be lifted. Install check valve between trap discharge and isolation valve. Layout and install pipe to minimize the lifting of condensate to the greatest extent possible.
2. Install check valve in each pump discharge line.
3. Install manually-regulated bypass valves around control valves at main building heat exchangers and each pressure reducing station. The bypass valve shall be equal in capacity to the control valve or PRV. Where an array of control valves or PRV's are used, i.e. 1/3 – 2/3 control strategies, the bypass shall be equal in capacity to the largest valve in the array.

C. **Specialties**

1. *Steam Trap Assemblies:* Unless indicated elsewhere in these guidelines, each condensate control point shall be composed of:
    a. A suitable designed drip leg, in accordance with industry standards.
    b. A gate valve, union, y-pattern strainer with blowdown valve and hose bib connection, a single trap (thermostatic, float and thermostatic, inverted bucket), a swing check valve and a gate valve, in accordance with industry standards and best practice.
    c. A line size bypass with gate valve (to support startup and trouble resolution).
    d. Compliant with condensate piping described under Part 1.
2. Install steam traps on the discharge side of all steam using terminal apparatus, steam headers, at steam mains, at the end of steam mains, at the end of branch piping exceeding 10 ft, at points where steam piping must rise, and elsewhere as required.
3. Install steam traps in accessible locations as close as possible to connected equipment, but not more than 48 inches from connected equipment.
4. Use float and thermostatic traps at heat exchangers.
5. *Drip traps:* Generally, use float and thermostatic or inverted bucket traps for systems 30 PSIG or less and thermodynamic or inverted bucket traps for systems over 30 PSIG.
6. *Moisture Separation;* Provide and install a moisture separator prior to:
    a. Steam Meter.
    b. Pressure Control Valve.
    c. Temperature Control Valve.
    d. Moisture separator to include a steam trap assembly.

D. **Other components not specifically identified**

1. Where the project requires items not mentioned herein, such as safety relief valves, expansion / bellows joints, diffusers, lift stations, pressure powered pumps, quench tanks, and others, provide those components consistent with the aforementioned and industry standards for Steam and Condensate. Components shall be from a single manufacturer when and where practical.

23 22 23 - Steam Condensate Pumps

Part 1 - Products

A. Pumps shall be cast iron, bronze fitted with mechanical shaft seals.

B. Receiver shall be heavy-duty cast iron with tappings for pump suction, condensate inlet, vent, drain, overflow and float control assembly.

C. Receiver shall have gauge glass and thermometer tappings and water level gauge and thermometer.

D. Pumps shall be duplex with lead-lag operation.

Part 2 - Execution

A. Connect to standby power. Provide high water limit alarm locally and at ASU BAS.

B. Vent through roof separate from the building vent.

23 23 00 - Refrigerant Piping

Part 1 - Products

A. Copper

1. Pipe: Type L, hard drawn, ASTM B88, dehydrated, cleaned and capped, ASTM B280, marked ACR.
2. Joints: Brazed, AWS A5.8, BCuP-5.
3. Fittings: Wrought copper, ANSI B16.22.

Part 2 - Execution

A. Install refrigerant lines in a manner so that the velocity in the evaporator suction line will move the oil and gas to the compressor. Oils shall be automatically returned on halocarbon systems. If vertical risers are required, provide riser of a size so that the oil will be lifted at minimum system loading and corresponding reduction of gas volume. Provide double risers if the excessive velocity and pressure drop exist.

1. Copper tubing/pipe shall be filled with nitrogen during the brazing process.
2. Slope
    a. Horizontal hot gas discharge 1/2” per 10 feet downward away from compressor.
    b. Horizontal suction lines 1/2” per 10 feet downward to the compressor. Do not create a situation where oil can separate from the suction gas and return to the compressor in slugs.
    c. Liquid lines may be installed level.
3. Insulate suction lines and hot gas bypasses if used.

23 31 00 – HVAC Ducts and Casings

Section 23 31 00 is for general HVAC applications only. Other materials, design and construction considerations shall be evaluated and proposed for special systems, such as laboratory and industrial exhaust systems. Consult with ASU Facilities Development Management (FDM) and Environmental Health and Safety (EHS).

Part 1 – Products

A. Galvanized Sheet Steel

1. Lock-forming quality; capable of double seaming without fracture, complying with ASTM A653 or A924 and having G90 coating; ducts shall have mill-phosphatized finish for surfaces exposed to view.

Part 2 – Execution

General

Pressure class for VAV systems shall be equal to the static pressure at the discharge of the supply fan but not less than 4” WG positive. Pressure class downstream of the air terminal unit shall not be less than 2” WG positive. Pressure class for ductwork on suction side of the AHU and/or suction side of return fan shall be equal to the static pressure at inlet of return fan but not less than 2” WG negative.

Pressure class for constant air volume system ductwork shall be equal to the external static pressure of the air handling equipment, but not less than 2” WG positive or negative.

Heat gain/loss, first cost and operating costs are affected by duct aspect ratio. Try to limit rectangular ducts to an aspect ratio of no larger than 4:1 (ratio of long side to the short side). For this reason, round duct is preferred over rectangular duct.

Seal duct seams and joints to meet SMACNA Class A for all ductwork. Leakage class for metal round and flat oval ducts shall be equal to **2**. Leakage class for metal rectangular duct shall be equal to **4.** All ductwork downstream of supply air fan systems and upstream of terminal control unit devices shall have duct leakage test performed by the installer. The Building System Commissioning Agent shall witness the duct leakage test. Test Report shall verify that proper test methods were used and the leakage rate for the system are within specified limits. Internal tie rods or bracing shall not be used for ductwork 36” or smaller (Where noise may be a concern).

Internal tie rods are not allowed for welded duct systems and special exhaust systems. Install duct free of

kinks, sags and dents.

Duct liner is prohibited.

Fiberboard duct is prohibited.

Exterior rectangular duct (or insulation) shall be pitched to prevent ponding.

A. **Flexible Duct**

1. Flexible duct may be used for duct connections to air inlets and outlets for sound attenuation purposes. Duct shall not exceed 7 feet in length.
2. Flexible duct shall not be used in inaccessible locations, over hard lid ceilings or penetrate walls or floors.
3. Flexible duct shall not be used on high pressure ductwork (3” WG and over or special exhaust systems.

B. **Elbows**

1. Rectangular, round and flat-oval duct, unvaned radius elbows with minimum centerline radius equal to 1.5 of the duct width are preferred. Use 1.0 radius elbows where 1.5 radius elbows to not fit.
2. Rectangular duct where 1.5 radius elbows to not fit:
    a. Supply
        i. Use 1.0 radius elbows or square throat elbows with turning vanes.
3. Return
    a. Use 1.0 radius elbows with splitter vanes or 45° throat with radius heel elbows with turning vanes.
    b. Square throat – radius heel elbows or square throat elbows with turning vanes shall not be used.

4. Exhaust: Turning vanes are prohibited.

C. **Duct Transitions**

1. Duct area should not be reduced more than 20% to avoid an obstruction.
2. When a duct transition with a constant area is to be used, a slope of 1 inch in 7 inches length is desirable. If this slope cannot be maintained for low velocity ducts, a slope not to exceed 1 inch in 4 inch length can be used.
3. For transitions where different size or different shape ductwork segments are connected, use concentric transitions unless otherwise shown. Unless otherwise indicated, make diverging transitions with maximum angle of 15° per side (30° total diverging) and converging transitions with maximum angle of 22.5° per side (45° total converging).
4. If reductions in area are required in main duct, the transformation should be located at or after a branch takeoff. Whether or not a reduction is required depends upon the air flow volume in the main and the air flow volume in the branch.
5. Limit reductions in rectangular duct to one dimension per transition.

D. **Branch Duct or Terminal Take-Off**

1. Full radius elbows shall be used for large branch take-offs from rectangular mains. The areas of the branch and main duct shall be proportioned based upon the air volume requirements for each duct.
2. Conical 90° tees, or 45° lateral tees followed by 45° elbows, shall be used for round ducts.
3. Design of rectangular branch duct take-offs shall consider air velocity, static pressure, and the ratio of branch air flow to main air flow.

E. **Rectangular Duct Longitudinal Seams**

1. Unless specified otherwise, use Pittsburgh lock seam.

23 31 10 - HVAC Ducts and Casings – Laboratory Exhaust

Section 23 31 10 is for laboratory exhaust ductwork applications only. Materials, design and construction considerations shall be evaluated for approval. Consult with ASU Facilities Development and Management (FDM), Environmental Health and Safety (EHS), and Capital Programs Management Group (CPMG) for specific applications not mentioned here.

Part 1 - Products

A. This section applies to general laboratory exhaust, fume hood, biosafety cabinet, radioisotope hood, vivarium supply and exhaust systems subject to routine decontamination. In some cases, extremely strong acids will attack 316L stainless steel fume hood exhaust duct. Chemicals to be utilized in the laboratories shall be considered before selection of ductwork materials to be specified for the laboratory exhaust ductwork. Coordinate with CPMG Project Manager (PM) and User Group for alternative materials.

1. Stainless Steel
    a. Type 316 stainless steel, 16 gauge, ASTM A167, Medium Pressure classification.
2. Fiberglass
    a. Thermoset FRP ducts and fittings.

Part 2 - Execution

General

Stainless steel shall be 316-L with welded longitudinal seams and welded transverse joints. Welds on exposed ductwork shall be positioned for minimum view and shall be ground and polished.

A. Hood exhaust should be manifolded together except for:
   1. Perchloric/hot acid hoods.
   2. Hoods with wash-down equipment.
   3. Hoods that could deposit highly hazardous residues on the ductwork.
   4. Exhaust requiring HEPA filtration or other special air cleaning situations where the mixing of exhausted materials may result in a fire, explosion, or chemical reaction hazard in the duct system.
   5. Manifolded fume hood exhaust ducts shall be joined inside a fire-rated shaft or mechanical room, or outside the building at the roofline.

B. Horizontal ducts must slope at least 1 inch per 10 feet downward in direction of airflow and drain to a suitable drain or sump.

C. Ducts should be constructed entirely of non-combustible material. Gaskets shall be resistant to degradation by the chemicals involved as well as fire resistant.

D. Laboratory Exhaust System shall be designed such that the exhaust fan is the last element in the system and no ductwork inside the facility is under positive pressure. Prior to use of laboratory exhaust system, a leakage test shall be performed to validate all joints and seams are air tight. The test can be performed at a positive pressure equal to the negative operating system pressure. Exhaust system ductwork shall be constructed to meet SMACNA Seal Class A. Ductwork leakage rate shall be less than 1% of the design flow with a goal of zero leakage. Leakage class for round or flat oval duct sections shall be equal to 2. Leakage class for rectangular duct sections shall be equal to 4. The Building Systems Commissioning Agent shall witness the duct leakage test. The final Test Report shall verify that proper test methods were used and the leakage rate for the system are within specified limits. In the case that the ductwork manufacture publishes a duct leakage test standard submit the procedure for approval to CPMG Project Manager.

23 33 00 - Air Duct Accessories

Section 23 33 00 is for general HVAC applications only. Other materials, design and construction considerations shall be evaluated and proposed for special systems, such as laboratory and industrial exhaust systems. Consult with ASU Facilities Development and Management (FDM), Environmental Health and Safety (EHS).

Part 1 - Products

A. Flexible Connections
   1. Neoprene coated glass fabric, fire retardant, waterproof, airtight, UV resistant (outdoor use) and comply with UL 214 and NFPA 90A.
   2. Manual Balancing Dampers
      a. Dampers shall be selected and properly constructed to prevent vibration, flutter or other noise.
      b. Provide with locking quadrants and position indicators.
      c. Sheet Metal screws are not allowed in construction of damper.

Part 2 - Execution

A. Fire/Smoke Dampers

1. Duct systems shall be carefully laid out to minimize the number of fire, smoke and fire-smoke dampers.

B. Manual Balancing Dampers

1. Provide balancing dampers to each diffuser and grille and elsewhere to facilitate system balancing. Dampers located at the face and neck of diffusers shall not be used in noise sensitive areas and should only be considered in hard lid areas.
2. Install dampers as close as possible to take-offs in a readily accessible location. Dampers shall be in the same room as the diffuser whenever possible with the damper handle clearly identifiable.
3. Splitter dampers and diverters shall not be used.

C. Access Doors

1. Provide access doors anywhere that maintenance, service, cleaning or examination is required, including automatic dampers, fire damper, smoke damper, smoke detector, fan bearing, coils, humidifier, filter, bird/insect screen, valve within duct or casing, outside air intake duct and at the inlet side of turning vanes in return ductwork.

D. Flexible Connections

1. Provide flexible connections between ductwork and fans or equipment subject to vibration that is not internally isolated. Width shall be suitable for the application but shall not be less than 4”

E. Pressure Relief Doors

1. Where the duct pressure class is not designated to accommodate the fan shut off head, provide pressure relief doors to open automatically to relieve excess pressure (both positive and negative) in ductwork where the fan static pressure could exceed duct pressure class and could damage ductwork. Also provide where fan motor VFDs are provided with a means to operate in bypass mode.

23 34 00 - HVAC Fans

Part 1 - Products

A. General Exhaust System

1. Fans shall be tested and certified in accordance AMCA 211 and bear the AMCA seal.
2. Each fan shall be statically and dynamically balanced to grade G6.3 per ANSI S2.19. Complete fan assembly shall be factory statically and dynamically balanced to meet BV-3 (minimum) per the latest AMCA 204-XX “Balance Quality and Vibration Levels for Fans”.
3. Direct drive fans are preferred over belt driven fans. For belt driven fans, furnish fans with V-belt drives with fixed-pitch sheaves. System air balancing shall be accomplished by either trial of different fixed-pitch sheaves or use of temporary adjustable-pitch sheaves. V-belts shall be rated for 150% of motor nameplate horsepower. For critical fan applications, provide V-belt drives at 200% of motor nameplate horsepower. A metal tag showing manufacturers model number, size and style of replacement belt set shall be attached to each belt guard. Provided with adjustment capability for tension and alignment. Multiple belts shall be factory matched sets.
4. For centrifugal, belt driven, non-plenum fans, arrangement 10 is preferred over arrangement 1, arrangement 1 is preferred over 9. Arrangements will vary depending on fan type and use.
5. Plenum fan arrangement 4 is preferred over arrangement 1, arrangement 1 is preferred over arrangement 3.

6. Each fan and motor combination shall be capable of delivering 110% of air quantity scheduled at the scheduled static pressure and the motor shall not operate into motor service factor.
7. Bearings shall be heavy duty, grease lubricated, pillow block, self-aligning ball or roller. Minimum life shall be 80,000 hours at ABMA-L10. Extend fittings to outside of drive.
8. Exhaust fans shall be provided with means of drainage.

B. Laboratory Exhaust System Fans

1. Laboratory exhaust fans shall be of the industrial type belt driven properly protected against corrosive and flammable materials. They shall be spark-proof and constructed of materials or coated with corrosion resistant materials for the chemicals being transported. V-belt drives shall be conductive.
2. Laboratory exhaust fans shall be oriented in an up-blast orientation.
3. Laboratory exhaust fans shall be mounted on spring type vibration isolators.
4. Discharge from exhaust stacks must have a velocity of at least 3,000 fpm. Achieving this velocity should not be done by the installation of a cone type reducer. The duct may be reduced, but the duct beyond the reduction should be of sufficient length to allow the air movement to return to a linear pattern. Strobic-type exhaust fans may be used to address exhaust velocity requirements (ANSI Z9.5, 5.4.6). Mixed flow dilution exhaust fans may be used to address exhaust velocity needs.

Part 2 - Execution

A. General Exhaust System Fans

1. Fans shall be selected based on total static pressure to best minimize energy consumption.
2. Limit inlet and outlet duct configurations that increase system static pressure due to system effect factors. Refer to AMCA 201. Where unavoidable, such factors shall be considered when selecting the fan.
3. Include drive losses in motor selection.
4. Select fan to operate at a single stable operating point. Fans having 2 potential operating points on the fan curve are not acceptable. Forward curved fans should be avoided for this reason.
5. Fans shall not be selected where the operating range of the system subjects the fan to operate under stall or surge conditions.
6. Exhaust fan discharge shall comply with code and recognized standards for general/relief or toilet exhaust systems.

B. Laboratory Exhaust System Fans

1. Laboratory exhaust fans shall be located outside the building at the point of final discharge to ensure that all the ductwork inside the building is under negative pressure.
2. Laboratory fan exhaust stacks shall extend at least 10 feet above the roof deck and shall terminate at or above the roof line as approved by the University Architect. Discharge shall be directed vertically upward (ANSI Z9.5, 5.4.6).

   Note: the University Architect shall be contacted for approval if any building feature, such as exhaust stacks, extend above the roofline.
3. Laboratory exhaust stacks shall terminate on the roof both downwind and as far away from building air intakes as possible to preclude re-circulation of laboratory exhaust emissions within a building. Exhaust systems shall discharge at a point where it will not cause a nuisance and from which it cannot be readily drawn in by a ventilating system. For specific minimum

distances between exhaust stacks and building intakes reference applicable building and safety codes and standards.

4. Rain caps that divert the exhaust toward the roof are prohibited.

23 36 00 - Air Terminal Units

Part 1 - Products

A. Units shall be pressure independent.

B. Control panels shall be mounted on the same side of the reheat coil piping.

C. Unit performance shall be certified in accordance with AHRI Standard 880.

D. Provide access panels upstream of coils.

E. Units shall be sealed to meet allowable leakage rates specified for low pressure ductwork.

Part 2 - Execution

A. Provide a minimum of 24” clearance in front of the unit controller. Coordinate with code required minimum clearances. Keep this clearance space unobstructed from below to maintain a path to this access space.

B. Maintain clearance to maintainable components, such as access panels, actuators, etc.

C. Minimum flow rates shall maintain the code required minimum ventilation rates when the spaces served are occupied.

D. Select terminal units to have at least 10 percent additional capacity of the outlets/inlets served for future considerations. The selections shall consider operating characteristics such as noise and pressure drop. The selection shall not cause the units to hunt.

E. In general, the selected unit’s maximum airflow should not exceed 75% of the rated capacity, and the minimum airflow should not be less than 20% of the rated capacity. Adjust as necessary with manufacturer’s written instruction.

F. Flexible duct shall not be connected directly to air terminal unit inlets. Provide straight length of hard duct at air terminal units. Coordinate the required straight length with the manufacturer’s instructions to optimize performance. The use of flow straightening devices are prohibited unless approved by variance.

G. 24V transformers shall be mounted individually at each terminal unit controller. Provide 120V power to the controller transformer.

H. Refer to Division 25 - VAV Terminal Unit Controller (VAV) for additional requirements.

23 37 00 – Air Outlets and Inlets

Part 1 – Products

A. General

1. Outlets and inlets shall be steel or aluminum and have baked enamel finish for standard air comfort applications uses. Other materials and finishes for aggressive environments shall be evaluated on a case-by-case basis.

B. Diffusers

1. Provide equalizing grids and pattern controllers as necessary of the application and installation.

C. Registers and Grilles

1. Supply registers and grilles shall be double deflection type with adjustable horizontal and vertical control.
2. Return and exhaust registers and grilles shall have fixed blade cores.
3. Fabric duct sock ducts and diffusers may be allowed by variance only.

Part 2 – Execution

A. Many factors affect the inlet and outlet selection and placement, including ceiling height, design temperatures, distribution system strategies, etc. Inlets and outlets shall be selected and laid out to best perform under these differing conditions to maximize space comfort, adequately distribute ventilation air and/or provide containment, makeup air and process control.

B. Overhead mixing systems shall be designed and laid out to achieve a minimum ADPI of 80%.

C. Outlets shall be selected to maximize performance under the full range of airflow for the space served. Outlet performance shall be evaluated at both minimum and maximum flow conditions.

D. Inlets and outlets shall be covered during construction before system startup to protect distribution and equipment from dirt, dust and debris.

23 40 00 – HVAC Air Cleaning Devices

Part 1 – Products

Coordinate the preferred manufacturer and model with ASU FM for each campus.
Size filter racks to receive one or more of ASU stock sizes:

ASU STOCK #	SIZE	DESCRIPTION
85133000	14 X 24 X 1 Pinch Frame	Filter Throw Away Frame Media
85133200	14 X 25 X 1 Pinch Frame	Filter Throw Away Frame Media
85133400	14 X 30 X 1 Pinch Frame	Filter Throw Away Frame Media
85133600	16 X 20 X 1 Pinch Frame	Filter Throw Away Frame Media
85133800	16 X 25 X 1 Pinch Frame	Filter Throw Away Frame Media
95134000	18 X 24 X 1 Fiberglass	Filter Throw Away Frame Media
85134100	18 X 20 X 1 Fiberglass	Filter Throw Away Frame Media
85134200	18 X 25 X 1 Pinch Frame	Filter Throw Away Frame Media
85134400	18 X 30 X 1 Fiberglass	Filter Throw Away Frame Media
85134600	20 X 20 X 1 Pinch Frame	Filter Throw Away Frame Media
85134800	20 X 25 X 1 Pinch Frame	Filter Throw Away Frame Media
85135000	20 X 30 X 1 Pinch Frame	Filter Throw Away Frame Media
85135050	22 X 27 X 1 Fiberglass	Filter Throw Away Frame Media
85135500	24 X 24 X 1 Pinch Frame	Filter Throw Away Frame Media

85136000	12 X 24 X 2 C Series	Filter Pleated Panel
85136500	12 X 24 X 4 C Series	Filter Pleated Panel
85140000	15 X 20 X 2 Fiberglass	Filter Throw Away Frame Media
85158200	16 X 20 X 2 35-40 Nb C Series	Filter Pleated Panel
85158300	16 X 24 X 1 7/8 C Series	Filter Pleated Panel
85158400	16 X 25 X 2 35-40 Nbs C Series	Filter Pleated Panel
85158500	18 X 24 X 2 35-40 Nbs C Series	Filter Pleated Panel
85158550	18 X 24 X 4 E-35 C Series	Filter Pleated Panel
85158575	20 X 20 X 1 C Series	Filter Pleated Panel
85158600	20 X 20 X 2 35-40 Nbs C Series	Filter Pleated Panel
85158650	24 X 24 X 2 E Series 55%	Filter Pleated Panel
85158700	20 X 20 X 4 C Series	Filter Pleated Panel
85158800	20 X 25 X 2 C Series	Filter Pleated Panel

ASU STOCK #	**SIZE**	**DESCRIPTION**
85158900	20 X 25 X 4 C Series	Filter Pleated Panel
85159000	24 X 24 X 2 C Series	Filter Pleated Panel
85161400	10 X 1 X 85	Filter Media
85161600	12 X 1 X 85	Filter Media
85161900	24 X 24 X 4 C Series	Filter Pleated Panel

Part 2 – Execution

A. Non-central air handling systems shall be equipped with replaceable filters with a 25% minimum dust spot efficiency (30% nominal efficiency, 96% arrestance) and a minimum reporting value of MERV 8.

B. Central air handling systems shall be equipped with replaceable pre-filters with a 25% minimum dust spot efficiency (30% nominal efficiency, 96% arrestance) and a minimum reporting value of MERV 8.

C. Central air handling systems shall be equipped with replaceable final-filters with a 80% minimum dust spot efficiency (85% nominal efficiency, 98% arrestance) and a minimum reporting value of MERV 13.

D. Filter frames shall be suitable for the velocity and differential pressure of the application to maintain an airtight seal from initial through final resistance. Frames shall be provided with gaskets and latching devices. Prefilter and final filters shall be installed in separate frames which allow the final filters to be replaced without having to remove the prefilters.

E. All air shall be filtered during construction.

  1. Construction filters shall be replaced during construction as needed to protect the equipment.
  2. Construction filters shall be replaced at the time the Owner accepts the building as complete.

F. Pre and final filter maximum face velocity shall be 500 fpm.

23 52 00 - Heating Boilers

The design professional shall consult with ASU FM and ASU CPMG Mechanical Engineer for boiler and feedwater selections.

Boiler safety controls and trim shall conform to Factory Mutual (FM) requirements and inspections certificates 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.

23 60 00 – Central Cooling Equipment

The design professional shall consult with ASU FM Mechanical Engineer for chiller and cooling tower selection.

23 73 00 - Air Handling Units

This section is intended for custom central air handling units. Packaged and semi-custom units shall incorporate the intent of these elements as is intended for a durable, efficient, maintainable and low leakage unit.

Part 1 - Products

A. **Base**

  1. Fully welded structural steel or fabricated steel.

B. **Floor**

  1. Constructed and sealed to meet maximum deflection and leakage requirements. Floor shall be welded to the unit base. Drive screws are not allowed. Use tread plate or finish with anti-slip epoxy.
  2. Floor, including integral recessed drain pans where used, shall be externally insulated to match unit housing performance and covered with a painted or galvanized liner. Design shall prevent condensation on exterior surface and provide a continuous vapor barrier at the liner.

C. **Housing**

  1. 4” double wall panel construction with internal support spaced to meet maximum deflection requirements. Minimum 2” double wall panel construction may be used for interior units located within conditioned spaces as long as performance requirements are met.
  2. Bolted construction preferred. Joints and seams shall be sealed to meet leakage rate.
  3. Exterior construction.
     a. Minimum 16 ga G-90 galvanized steel, primed and painted.
  4. Interior construction.
     a. All sections shall have solid inner surface faces.

   b. Minimum 20 ga G-90 galvanized steel.
   c. Minimum 18 ga stainless steel at cooling coil section and access section downstream of coil to fan inlet.

5. Insulation for exterior/unconditioned space installations shall have a maximum U-value of 0.06 Btu/hr ft^2 ^{o}F. Interior units installed in conditioned space shall have a maximum U-value of 0.12 Btu/hr ft^2 ^{o}F.
6. Incorporate thermal break construction to prevent condensation on the outside surface of the unit casing where units are installed in exterior and/or unconditioned space. Thermal break calculations shall be submitted for review and approval as part of Shop Drawings.
7. Provide blank off panels to prevent air bypass around equipment.
8. Exterior installation roofs shall be standing seam, water tight, pitched a minimum of ¼” per foot.

D. Access

1. Doors shall be of same construction as housing panels. Each door shall have a **12x12** double paned window.
2. The door frame shall be one piece with high performance knife-edge and replaceable neoprene gasket seal.
3. Doors shall have similar thermal break as housing.
4. Doors shall open against pressure. Preferred minimum door width is 24”. Coordinate door width with equipment removal requirements. Provide removable panels as required. Height shall be 72”. If unit is shorter than 72”, minimum height shall be 48”.
5. Provide platform and steps at doors for outdoor units installed 24” above finished roof level.
6. Provide latches similar to Ventlok 260.

E. Cooling Coil Section

1. Support coils by stainless steel frame independent of unit casing. Blank off panels shall be stainless steel.
2. Each coil bank shall include minimum 16 ga stainless steel all welded, double sloped condensate drain pans. Provide intermediate drain pans where coils are stacked. Condensate drain pans shall have sufficient depth to hold condensate and shall be a minimum of 2” deep. Drain pans shall extend a sufficient length upstream and downstream of the coil to collect condensate, but no less than 12” downstream of the coil and 4” upstream.
3. Coil sections shall have tracks that extended the full width of the unit and depth of coils to provide easy removal of service and maintenance.

F. Fans and Motors

1. Plenum/plug type with airfoil blades, arrangement 4 are preferred.
2. Flexible connections to fan inlets shall be fastened with sheet metal screws. Clips are not allowed.
3. Provide overhead track or eye bolts to aid in the removal of fans. Track should be used for fan motors 25hp or over.

G. Control Dampers

1. Dampers shall AMCA Standard 500 certified low leakage dampers.
2. Damper frames shall be extruded aluminum. Outside air damper frames shall be insulated

on all sides.

3. Blades shall be extruded aluminum airfoil shaped, double skin construction. Outside air dampers shall be internally insulated.
4. Provide multiple dampers to minimize racking and binding. Maximum damper section shall be 48” x 48”. Provide stiffeners between damper sections for maximum rigidity.
5. Damper blade axles shall be hexagonal steel and provide positive locking connection to blades and linkage.
6. All linkage must be exposed to insure easy accessibility for adjustment and maintenance. Linkage shall be factory set-up for smooth damper operation. Damper operation shall be factory tested.
7. Damper leakage for a 48” x 48” damper shall not exceed AMCA 500 Class 1 rating at 4” WG pressure difference.
8. Pressure drop for a 48” x 48” damper shall not exceed .05” WG at 1,000 fpm full open.
9. Provide individual actuators for each section of control dampers. Size actuators to operate with sufficient reserve power to provide smooth modulating action or 2-position action.

H. **Electrical**

1. Each access section shall be provided with a minimum of one light. Number of lights shall be sufficient to allow for adequate inspection and maintenance. LED lights are preferred.
2. Provide convenience outlets at fan section(s), both inside and outside the unit.

Part 2 - Execution

A. Units shall be in a draw thru arrangement with the supply fan downstream of the cooling coil.

B. Provide diffuser section to distribute fan discharge air evenly over unit as necessary.

C. Factory leak test full assembly. Leakage shall not exceed 1% at 1.5 times the operating pressure, or 10” WG whichever is less.

D. Factory test full assembly. Maximum allowable deflection shall not exceed 1/200th of any span in any direction at minimum 10” WG (positive for discharge side of fan and negative for suction side of fan) or supply fan design static discharge pressure, whichever is higher.

E. Outdoor air handlers: VFD mounted at the air handler shall be accessible from outside the air handler. When VFD’s are cooled by air from the air handler, do not use air that could cause condensing at the VFD.

F. VFD frequency at design conditions shall be limited to 60 Hz maximum.

G. Field mounting of any equipment on housing walls or roof is not allowed. Field mounting of services that will restrict access to the unit service sections is prohibited.

H. Silencers or attenuators may be used to meet noise criteria, however they shall not increase the fan total static pressure.

I. Motor sizes in excess of 40 horsepower shall be pre approved by ASU.

J. Intake louver maximum face velocity shall be 500 fpm through the net free area.

23 82 16 - Air Coils

This section is intended for coils in packaged, semi-custom and custom air handling units. Velocity requirements are for all coils.

Part 1 - Products

A. Chilled Water Coils

1. Coils shall be constructed with 5/8" O.D. seamless hard copper tube. Tubes shall have a minimum wall thickness of .035", pitched in the casing to the headers for proper drainage. Provide with turbulence enhancers where required to improve capacities at low flow.
2. Coils fins shall be continuous plate fin. Maximum fin spacing shall be 10 fins per inch.
3. No coil shall have more than 8 rows depth.
4. Casings shall be minimum 16 gauge galvanized steel with allowance for expansion and contraction. Use stainless steel casings for 100% outdoor air units.
5. Coils over 42" in length shall have steel center support. Coils over 96" in length shall have two tube supports.
6. Coil assembly shall have provisions to facilitate total removal from coil bank.

A. Hot Water Coils

1. Coils shall be constructed with 5/8" O.D. seamless hard copper tube. Tubes shall have a minimum wall thickness of .035", pitched in the casing to the headers for proper drainage. Provide with turbulence enhancers where required to improve capacities at low flow.
2. Coils fins shall be continuous plate fin or serpentine.
3. Casings shall be minimum 16 gauge galvanized steel with allowance for expansion and contraction.
4. Coils over 42" in length shall have steel center support. Coils over 96" in length shall have two tube supports.
5. Coil assembly shall have provisions to facilitate total removal from coil bank.

Part 2 - Execution

A. Offset coils as required to allow for removal. Coils should be piped in counterflow arrangement.

B. Cooling coil selection: Minimum coil dT shall at least be that of the plant designed dT or higher. Supply water temperature should at least be 1°F higher than design inlet water temperature to account for coil fouling.

C. Coil ends shall have removable casing panels. Coils shall have air vents that are automatic and that extend out of the casing so that they are accessible.

D. Each coil shall be provided with fittings and valves 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.

E. Coils shall be selected with a minimum velocity of 3 fps.

F. Coil maximum face velocity shall be:

1.	Cooling coil face velocity	450 fpm
2.	Heating coil face velocity	600 fpm

Preferred water-side and air-side pressure drops shall not exceed 10 feet and 0.75” WC respectively.

Arizona State University Division 25 Design Guideline Executive Summary

The Division 25 Guideline presents a thorough framework for the design, installation, implementation, and management of Building Automation Systems (BAS) at Arizona State University (ASU). This document aims to enhance system reliability, energy efficiency, and ease of maintenance through detailed guidelines and standards.

This document creates a thorough description of the intent of ASU to have innovative, sustainable and comfortable buildings, while enhancing the ability of the facilities teams to operate, maintain and plan for current and future building use.

The system designer will find the details necessary to provide project documentation that will guide the contractors, system integrators, and commissioning agents towards the vision of ASU. Contractors and system integrators will find standards for configuration and implementation of the building design to comply with the performance standards established by ASU.

Each section contains responsibilities for the parties involved in building design, construction, and operation for the application of that section to the process.

The vision of the guideline is to provide a framework of design that informs ASU's partners of the overall vision while allowing latitude for innovation. As the guideline is used it is expected that the designers, processes, and lessons learned will add to the framework to create ever improving buildings for the education of ASU students.

Section 1 – Design, Installation and Software Agreements

Overview

This document will cover the guidelines for design and installation within the Arizona State University (ASU) Building Automation System (BAS) database.

Quality Assurance

General

A. The BAS shall be fully integrated into the campus network as a complete package by the factory authorized distributor awarded the project in accordance with the requirements herein with

   1. guidance from Capital Program Management Group and Facilities Management. The campus BAS network shall be designed around Tridium Niagara. The System shall include all wiring, piping, installation supervision, calibration, adjustments, and programming checkout necessary for a complete and fully operational system.

B. The Building Automation System Contractor shall be a factory owned branch office that is regularly engaged in the engineering, programming, installation and service of Building

   1. Automation Systems of similar size and complexity. Employees responsible for the design and implementation shall be factory trained.

C. If multiple BAS contractors are considered for a project, ASU may choose to contract with a Master System Integrator to integrate the project into the ASU enterprise BAS.

D. The BAS 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.

E. The BAS Contractor shall be responsible for all work fitting into place in a satisfactory and neat workmanlike manner acceptable to the Owner/DP.

F. The BAS 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.

Experience

A. The BAS Contractor must have at least ten years of experience in the complete, turnkey installation of Building Automation Systems that are of comparable size and technical complexity.

B. The BAS Contractor's project team must include specialists in the following

  1. areas of Facilities Management Systems:
  2. Programming, Engineering, Field Supervision, and Installation. Specialists shall have a minimum of five years of experience with Building Automation Systems.

Products

A. The Building Automation System architecture must include products from a manufacturer that regularly produces Building Automation Systems, utilizing the manufacturer’s latest standard design. Controllers and DDC (Direct Digital Control) system components should be current production items.

  1. Documentation for proof of latest technology installed.
  2. Provide documentation for software and firmware versions proposed.
  3. Software versions should comply with the ASU current approved version.

B. All other equipment shall be the products of the BAS manufacturers or of an approved manufacturer regularly engaged in production of specialized Building Automation System materials or equipment.

Governing Code Compliance

A. The BAS Contractor shall comply with all current governing codes ordinances and regulations, including ASHRAE, UL, NFPA, the local Building/Fire Code, NEC, and so forth.

Work by Others

Mechanical Contractor

A. Installation of automatic control dampers, smoke control dampers, and necessary blank off plates.
B. Access doors where and as required.
C. Installation of immersion wells.
D. Installation of flow switches
E. Installation of automatic control valves
F. Installation of pressure taps, hot taps, and associated shut-off cocks.
G. All mechanical submittal data for equipment governed by this section must be supplied by the Division 23 contractor to aid in the preparation of the Direct Digital Control System submittal.

Electrical Contractor

A. Installation of 120vac power to DDC controllers shown on the electrical drawings shall be the responsibility of the Division 26 contractor.
B. Installation and power wiring of all Variable Frequency Drives (VFD's) shall be the responsibility of the Division 26 contractor. VFD's shall be BACnet compatible.
C. 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

Electrical work shall, in general, comply with the following:

A. Electrical work may include both line voltage and low voltage wiring as required.
B. Conduit for electrical power systems may be used for running control high voltage wiring.
C. All electrical work shall comply with the N.E.C. and local electrical codes.
D. All safety devices shall be wired through both hand and auto positions of motor starting device to insure 100% safety shut-off.
E. 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.
F. The motor starter supplier shall provide auxiliary contacts as required for interlock by BAS 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.
G. Low-voltage plenum rated wiring can be unexposed above an accessible

ceiling. Wiring shall be installed in J-hooks, Electrical Metallic Tubing (EMT), or other wire management devices and not laid on ceiling tile. All wiring in mechanical or electrical rooms shall be in conduit.

H. All devices must be enclosed. If a cover is not part of a device, it must be mounted in a separate enclosure.

I. Each DDC controller must have an independent switch to disconnect power.

Work Included

Installation of Building Automation System (BAS)

A. The BAS Contractor shall furnish and install a complete Building Automation System (BAS) for all mechanical systems and other facility systems as included in the project documents.

B. All device locations shall be safe from water damage. Nocontrol devices

1. including VFD's will be mounted under piping, valves or wall penetrations where water leakage or other damage may occur.

C. In addition, the following apply:

1. The work under this Section shall include all materials and labor to perform all work required for the installation of the BAS as specified.
2. The drawings and Specifications are complementary to one another. Where conflicts exist between the Specifications and/or drawings, the more stringent requirement shall apply.
3. The BAS 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.

Submittals

A. The BAS Contractor must submit installation drawings, Network Architecture riser diagrams, and control strategies for review within 60 days after the award of project.

B. Each submittal must include a cover sheet that contains the following information: submittal ID number, date, project name, address, and title; FMS Contractor's name, address, and phone number; and the names and phone numbers of the FMS Contractor's project manager, quality control manager, and project engineer.

C. Each submittal shall include the following information.

1. BAS riser diagram showing all DDC controllers, operator workstations, network repeaters, and network wiring.
2. One-line schematics and system flow diagrams showing the location of all control devices.
3. Vendor's own written description for each sequence of operations, to include the following:
    a. The sequences of operations provided in the submittal by the BAS contractor shall represent the detailed analysis needed to create actual programming code from the design documents.
    b. The sequence of operations shall cover normal operation and operation under the various alarm conditions applicable to that system.
4. Detailed Bill of Material list, identifying quantity, part number, description, and associated options.
5. 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:
    a. Code Number, Fail Position, Damper Type, Damper Operator, Blade Type, Bearing Type, Seals, Duct Size, Damper Size, Mounting, and Actuator Type.
6. 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:
    a. 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.
7. Cataloged cut sheets of all equipment used. This includes, but is not limited to, the following: DDC panels, peripherals, sensors, actuators, dampers, control components, and so forth. Indicate all specific device option selections on the cut sheets.

D. BAS Contractor shall not order material or begin fabrication or field installation until receiving authorization to proceed in the form of an approved submittal. BAS Contractor shall be solely responsible for the removal and replacement of any item not approved by submittal at no cost to the Owner.

E. Hardware, Shop Drawings, Software and Graphics submittals shall be provided to ASU Facilities Development and Management (FDM) for approval prior to installation.

Operation and Maintenance Manuals

A. Include the following documentation:
  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.
  6. Sequence of Operations
     a. Sequence of Operation should contain the point name for each value referenced in the Sequence of Operation.
     b. Include all modifications and additions from coordination with equipment manufacturers and commissioning.
  7. Software Point Name Abbreviation List. Include Name, Description, Associated Control Panel, Point Type and Point ID.
  8. I/O Point List. Include Point Name, Controller Location, Point Number, Control Device, Range and Span.

B. Provide copies of all manufacturers manuals covering the installed system.

C. As-Built Record Drawings including but not limited to:
  1. Network Riser Diagram showing all IP addressing, BBMD, communications gateways and BACnet/Modbus addressing where appropriate.
  2. All controller wiring
  3. All sensor wiring
  4. As-Builts of all flow and equipment diagrams
  5. Updated Sequence of Operations as described above.
  6. All instance numbers and MAC addresses for IP, BACnet, or Modbus devices.

Warranty

Material

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 of 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 BAS Contractor free of charge.

Installation

The Control System shall be free from defects in software, hardware, programming, and in installation workmanship for a period of one year from acceptance. The BAS Contractor shall, free of charge, correct any defects in workmanship within one week of notification in writing by the Owner.

Commissioning

A. Commissioning the Building Automation System is a mandatory documented performance requirement of the selected BAS Contractor for all control systems. Commissioning shall include verification of proper installation practices by the BAS Contractor rand subcontractors, point verification and calibration, system/sequence of operation verification with respect to specified operation, and network/workstation verification. Verification that all meters required by the EIS system are working properly and communicating properly with the campus EIS system. Documentation shall be presented upon completion of each commissioning step and final completion to ensure proper operation of the Building Automation System.

1. Commissioning Agent should be an independent third party.
2. Commissioning documents shall be provided to ASU FDM upon completion.

B. Testing Procedure

1. Upon completion of the installation, the BAS Contractor shall start-up the system and perform all necessary testing and run diagnostic tests to ensure proper operation. The BAS 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 jumping 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. The sample size of this step should be adjusted by the criticality of the application being tested.
5. All central plant and critical equipment 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.

Training

Training shall be provided for all systems as follows:

1. Factory training for 2 ASU operators.
2. The control contractor shall provide an 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. On-site training hours may be increased if necessary, but will generally adhere to the following guidelines:

   a) Provide 8 hours of initial operator training immediately after completion of commissioning.
   b) Provide 4 hours of additional on-site training 6 months after owner acceptance.
   c) Provide 4 hours of additional on-site training 12 months after owner acceptance before expiration of the project warranty.

License Agreements

All software and device licenses shall be provided with free updates for the entire warranty year under the provisions of the construction contract. A minimum of a three (3) year software maintenance agreement (SMA) will be included in contract pricing for all software and device licenses provided. If there is an existing Software Maintenance Agreement (SMA) for the provided software or device licenses, the new software or devices will be added to that SMA. The awarded contractor will be responsible for all costs and administrative tasks associated with the additional licenses.

Design and Coordination Considerations

Design Engineer

The design engineer will use this section to guide development of the project documents for all building systems including but not limited to Building Automation Systems, Energy Information Systems, Fire Alarm Systems, and Lighting Systems.

Master System Integrators and Automation Contractors

The master system integrator or BAS contractor must be available during the design process to offer guidance on the compatibility of the specified systems with the current ASU project guidelines.

Project Commissioning

Analyze project documents for meeting the required intent of the ASU design guidelines and develop a comprehensive commissioning plan to capture all project requirements.

Arizona State University

ASU should be prepared to assist the design and commissioning team with integration of the project guidelines into the project, as well as access to current vendors that are partnering with ASU in the implementation of projects that meet the current ASU design guidelines.

Section 2 – Network Infrastructure

Intended Audience

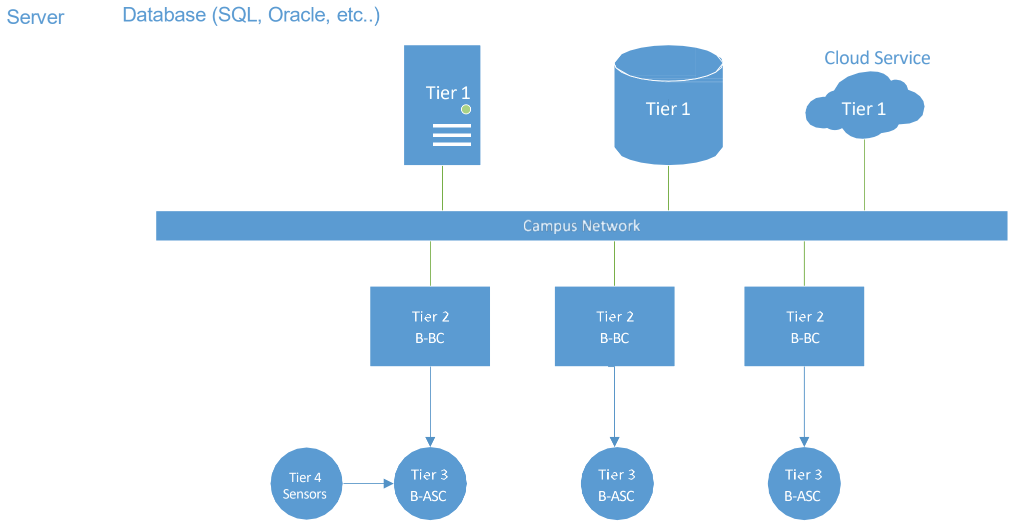
The purpose of this document is to provide an overview of Building Automation System (BAS) network infrastructure and overall purpose of design for Arizona State University (ASU).

Philosophy

Automation refers to the ability to execute algorithms with minimal human intervention. This concept is implemented through distributed logic, which is a crucial aspect of designing any automation network. Distributed logic is realized when all devices within the automation network are programmed to operate independently of one another. This method enhances redundancy and fault tolerance, with minimal data exchange being optimal for achieving full autonomy.

Building Automation System definition

BAS networks consist of a multiple tier design that allow for the expansion of direct digital control systems. A BAS network is comprised of a series of tiers. The complexity of control available, and the responsibility for building operation increases as you change tiers. The tiers can be defined as follows:



4th tier - Field Level: This is the lowest tier, where sensors, actuators, and other devices are directly connected. It involves real-time monitoring and control of individual components like valves, motors, and temperature sensors.

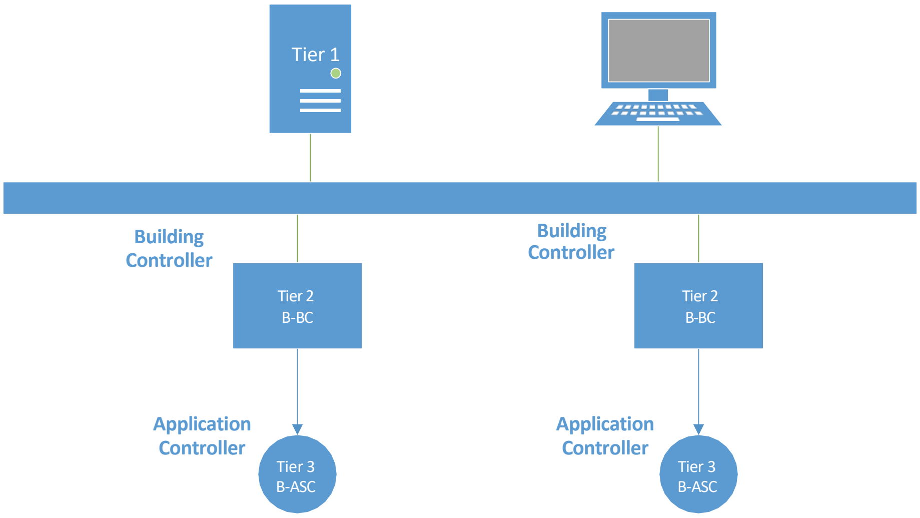
3rd tier - Control Level: This tier consists of controllers that gather data from the field devices and execute control algorithms. It includes programmable Direct Digital Controllers

(DDC) that manage the operation of equipment based on predefined logic.

2nd tier - Supervisory Level: This level involves the management of multiple control devices and provides higher-level oversight. It often includes a Building Automation System (BAS) that aggregates data from various controllers and allows for monitoring, reporting, and management.

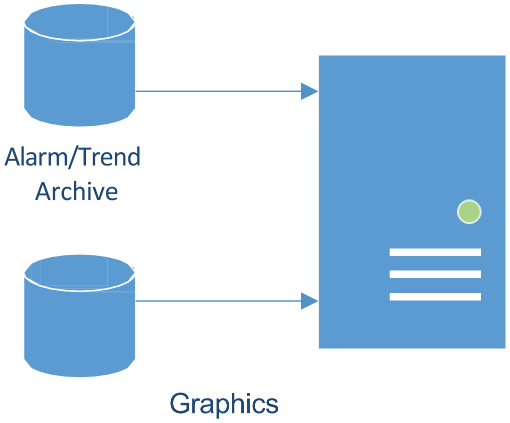
1st tier - Enterprise Level: The top tier, which interfaces with other systems and provides integration across different buildings or facilities. This level may include advanced analytics, reporting, and the ability to manage energy consumption or other enterprise-wide strategies.

These tiers work together to create a comprehensive control system that enhances operational efficiency, monitoring, and management capabilities.



Building Automation System Architecture

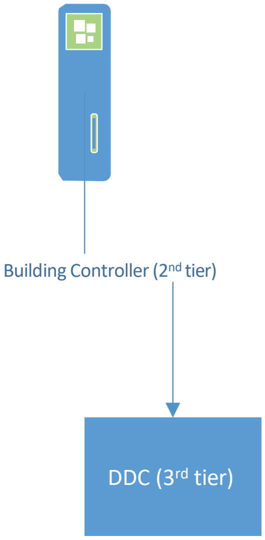
The first tier comprises two components. The first component is the User Interfaces, which include software applications or dashboards that enable users to monitor and control the system. This can involve graphical user interfaces (GUIs) on computers or mobile devices. The second component is Data Logging and Storage, which consists of elements that record operational data for analysis and reporting, aiding in the monitoring of system performance and energy consumption.



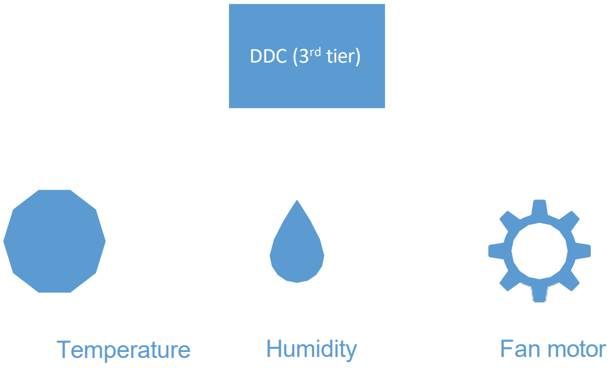
The second tier consists of building controllers that monitor, collect data, and implement supervisory logic to ensure that the individual DDC devices (3rd tier) function effectively within the overall automation network. Building controllers communicate with these 3rd tier devices using various protocols such as BACnet, Modbus, and Lonworks1 (LON).

Depending on the 3rd tier device, different communication mediums like RS-485, IP, and wireless technologies may be required. The ability to integrate multiple protocols allows for support of both open and proprietary communication styles.

Lonworks terminology is included because it is a traditional open protocol and may be encountered in existing facilities. The installation of new Lon works networks should be avoided in ASU projects.



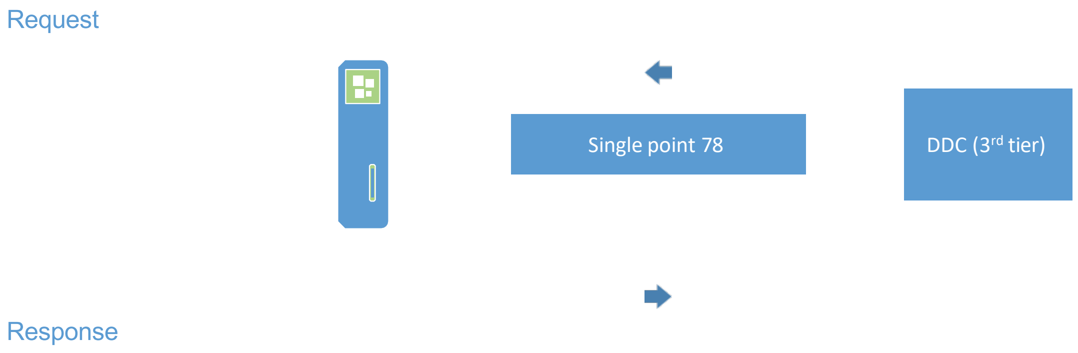
Third tier devices are designed to support two types of applications programmable or application specific. Application specific controllers require configuration of parameters. Programmable devices have more flexibility and can support a wide range of mechanical sequence requirements.



Open Protocol Implementation

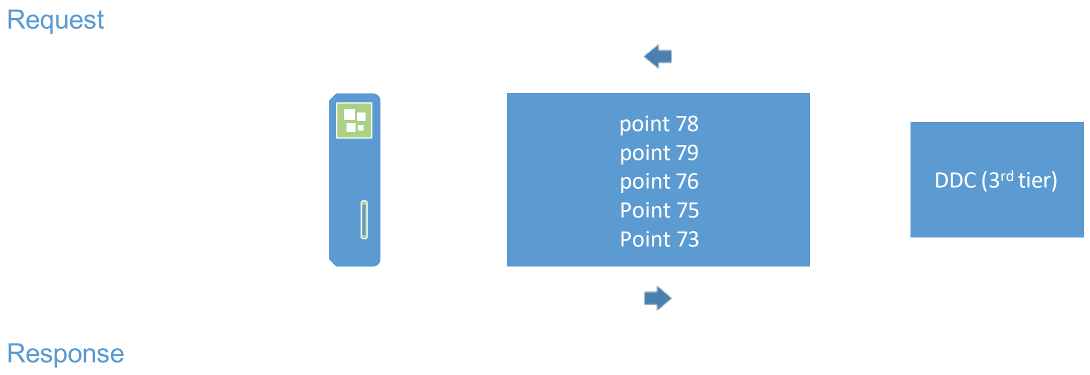
Understanding of poll versus push protocols

Modbus is a poll-based protocol that requires continuous requests to verify the value or status of a point even if the value has not changed. In a Modbus network, the manager device polls subordinate devices to request data or commands. The manager sends a request, and the subordinate responds with the requested information or acknowledgment. This polling mechanism allows for communication between devices in a structured manner, ensuring that data is exchanged in an orderly way.



Modbus most beneficial performance is accomplished when points are requested in groups. In Modbus communication, a group request refers to a method where a manager device can request data from subordinate devices in a single message. This is particularly useful for reducing communication overhead and improving efficiency in systems where multiple devices need to be monitored or controlled synchronously. Overall, group requests

help streamline communication in Modbus networks, making them more efficient and reducing network congestion. Complexity of polling is based on the Modbus implementation of each manufacturer.



BACnet

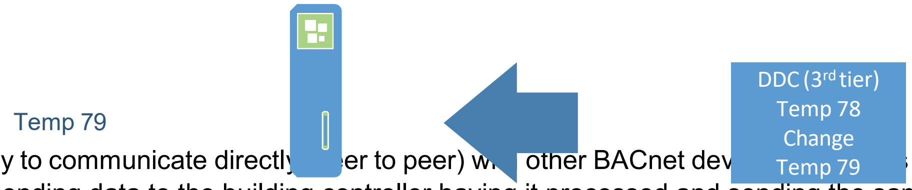
Building Automation and Control Network (BACnet) is primarily considered a polling protocol, meaning that devices typically communicate in a request-response manner, where a manager device requests information from subordinate devices. However, BACnet also supports a push- driven approach through its notification services, allowing devices to send unsolicited messages to other devices under certain conditions.

Polling: Most standard communication in BACnet involves the manager polling subordinate devices for data, such as readings from sensors or status updates.

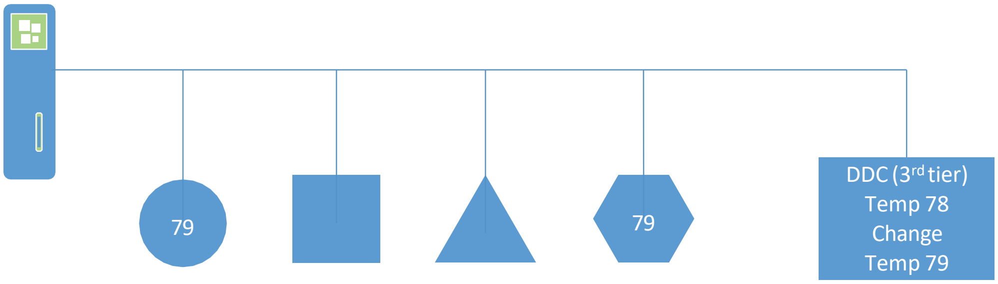
Unsolicited Notifications: BACnet allows devices to send unsolicited notifications (like alarms or event notifications) to other devices without waiting for a request. This is where the push- driven aspect comes into play.

Event-Driven Communication: BACnet is designed to support event-driven communication, enabling devices to react to changes in status or conditions and notify other devices accordingly.

In summary, while BACnet operates mainly as a polling protocol, it does incorporate push- driven elements through its support for unsolicited messages and event notifications.



The ability to communicate directl eer to peer) w other BACnet dev the necessity of sending data to the building controller having it processed and sending the same data to other devices.



Network & Hardware Guidelines

The tier1 server will use Windows or Linux base operating system server. The functions of a tier one server at a minimum are as follows:

- Trending and alarming reports database will reside.
- Integration of multiple server/client protocols

- Support a network of tier 2 controllers in each facility.
- User interface for the Graphical User Interface (GUI) via web browser or thick client
- Authentication will support strong password,
- User authentication will be capable of being managed with LDAP or SAML. SAML is the preferred method of authentication management.
- Administrative levels for users

External archiving will be executed through a third-party Relational Databases such as MySQL, PostgreSQL, Microsoft SQL Server, Oracle DBMS, SQLite. The tier one server will work in conjunction with the third-party relational database. It is recommended to install external archiving software on separate servers.

Tier two controller will be IP based hardware or virtual device supported in Linux or Windows environment. The functions of a tier two controller at a minimum are as follows:

- Will host one or more tier 3 controllers.
- Support protocol integration.
- Supervisory logic of multiple tier 3 controllers.
- Normalization of data for trending and alarming
- Local trending and alarming
- Domain Name Server (DNS)
- Storage of reporting data like trend and alarms
- Simple Mail Transfer Protocol (SMTP) with encryption

Tier three controller advanced application or application specific controller will be based on IP or RS-485 open protocols. The functions of a tier three controller at a minimum are as follows:

- Universal hardware I/O
- HMI interface
- DNS (IP)
- Local Trending an Alarming
- Hand Off Auto (HOA) points for manual override

Third-party equipment, including but not limited to electric meters, generators, automatic transfer switches, air handling units, and humidifiers, will communicate over either the BACnet IP (network-based protocol) or BACnet MS/TP (manager-subordinate/token- passing) network, or through Modbus TCP (Ethernet-based protocol) or Modbus RTU (remote terminal unit) serial communication protocol.

Data exchange and data collection will remain under the distributed logic concept. This means data exchange and collection is accomplished in ascending order of tier 3 to tier 2 devices. Tier 2 devices can then distribute data to tier 1 devices. It is not recommended to collect data from an RS-485 tier 3 controller device straight to a tier 1 device. The ASU Project Manager may make exceptions to this with the coordination of the ASU Facilities BAS Team.

Physical Network

The BAS data communication will reside on the respective facility's data network. All network switches, routers, fiber optic and copper Ethernet cabling will be provided and supported by the local Enterprise Technology (ET) department.

The ET department will assign all IP addresses for the BAS contractor's use and configure the necessary VLAN segmentation and routing. This process will require documentation of MAC addresses by contractor.

The ET department will provide all the means of connecting each IP-based controller to the Ethernet network. Connection in all phases of the project should be by one of the following methods:

- The ET department will provide the patch cables of the appropriate length to connect each IP-based controller to the Ethernet network through a RJ-45 data jack.

The BAS contractor will coordinate the quantity and location of the IP-based controllers with the facilities and ET departments prior to installation. Each IP-based controller shall be identified and shown on project construction documents technology drawings.

IP-based Controller

The selected controller is an IP based controller running the latest manufacturers stable release software and integrated using open communications protocols approved by the local facilities department.

Controllers and any other devices connected to the BAS network equipment will support the security standard of IEEE 802.1X for port-based Network Access Control.

Tier 2 IP controllers will be mounted in Intermediate Distribution Framework (IDF) rooms, electric rooms, or mechanical spaces, with a dedicated 120V, 20A emergency power circuit served by the building emergency power system. The BAS contractor will coordinate quantity and location of all panels/enclosures for power connection and data network connection.

The IP controller will utilize a static IP address. The contractor will coordinate network switch assignments and IP addresses with in a timely fashion with ASU ET Department to meet the required project schedule.

Prior to address and port assignment the contractor will provide the following items to ET staff:

- Room number where the controller is located.
- IDF room that will serve the controller.
- Controller Model Number,
- Controller Serial Number
- Media Access Control (MAC) address
- TCP/UDP Port list with protocol details

ASU ET department will coordinate the address and port assignments and provide the following:

- IDF Room assignment
- Network Switch Identifier
- Port Assignment
- IP Address
- Subnet Mask
- Default Gateway
- Primary and Secondary DNS Server Assignment
- SMTP Configuration Information

Network Security, Access, and Authentication

ASU ET staff will provide all firewalls and control all port routing and assignments to manage the data network access and security.

Access will support HTTPS (Hypertext Transfer Protocol Secure) and TLS (Transport Layer Security) latest revision with backward compatibility to revision 1.2 for network authentication.

TLS will be set to the latest approved version for all IP based controller hardware to ensure secure authentication.

User login to the BAS network will support Lightweight Distribution Access Protocol (LDAP) for active directory authentication. If single sign-on is necessary, Security Assertion Markup Language (SAML) support will be needed. Firewall rules between facilities should be built around the following software protocol ports:

Protocol	**TCP/UDP**	**Port**
HTTPS	TCP	443
SMTP	TCP	587

The following software protocol ports may require configuration depending on site configuration:

Protocol	**TCP/UDP**	**Port**
BACnet IP	UDP	47808

BACnet SC	TCP	1443
Modbus TCP	TCP	502

Software Deployment

The automation software will be deployed in cooperation with local ET staff. The coordination will ensure installation of the latest manufacturers stable release currently on the tier one Server. A central server for the automation network is recommended with access for the local staff done via thin client workstations. Additional software can be installed for programming and configuration as needed by the facilities department. All other operators will access the system through a web browser interface.

Computer hardware and operating system requirements will be coordinated with the manufacturer’s recommendation in advance of each software installation.

The programming shall be graphical object based and allow the user control of all schedules, adding or removing objects, capable of historical data collection and generate priority-based alarms with remote notification. Third-party driver files or custom driver files from a contractor will not be allowed without prior approval of ASU FDM Energy Management Department. All programming and administration control shall be handed over to ASU FDM Energy Management Department upon completion of each project.

The selected automation contractor will work in collaboration with the local ET department for the following:

- Access to network for the specific facility being serviced during the installation, commissioning, and maintenance process to properly program and support the automation controllers and associated systems or equipment.
- Assign all required credentials for each team member of the automation contractor requiring access to the local network.
- Access to the local network will be restricted at the discretion of the ET Department. During the vetting and implementation process, access may be revoked at any time.
- Access must be coordinated, tested, and verified before the permanent installation of the automation controller/s connection to the local network.
- The automation contractor is required to comply with all local ET policies and provide all the information requested for approval and configuration access to any existing network/s.

After construction is complete, the automation contractor will coordinate with ASU ET staff the following actions:

- Removal of access credentials for the construction personnel no longer requiring access to local network or workstations.
- Add credentials for the assigned service personnel requiring access to the automation network and workstations for on-going service and maintenance.

Access or lack thereof will always be at the discretion of the ASU ET Department.

Databases Backups Schedules & Maintenance

The Tier 1 server will perform a weekly backup of all Tier 2 controllers on the network outside of normal working hours.

The system will store a copy of the last three backups.

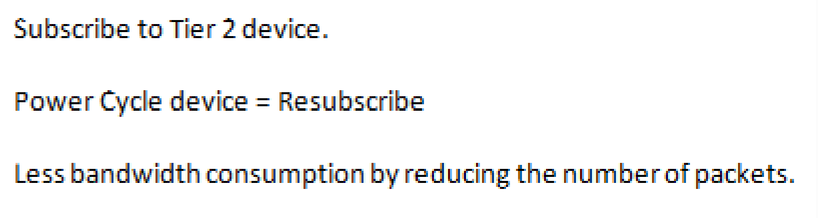
Access & Data Protocols

Access to Network

The primary access protocol used at the tier one and tier two automation level with be HTTPS or the manufacturers encrypted secure protocol that is native to the automation system. The selected protocol will facilitate all communications between facilities for monitoring, alarming, trending, and maintenance.

Peer to Peer

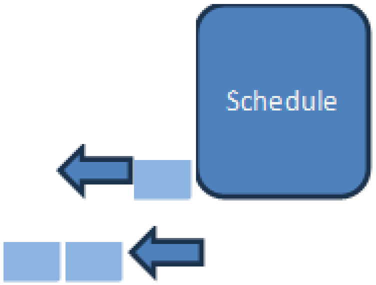
The primary data protocol for field devices will be BACnet as established and defined in ASHRAE Standard 135, Annex J. Annex J defines a network comprised of a group of devices that communicate among themselves using the BACnet protocol.



Subscribe to Tier 2 device.

Power Cycle device = Resubscribe

Less bandwidth consumption by reducing the number of packets.



Some equipment deployed on the field device network will implement Modbus as defined in the Modbus Application Protocol V1 1b3. This is an open protocol for server/client communications between a Modbus network server and its network of standalone devices.

Additional Protocols

Additional protocols are permitted across the network at the discretion and approval of ASU FDM Energy Management Department staff.

Wireless Protocols

Wireless protocols, like ZigBee or EnOcean, are not an accepted form of communication for the BAS, on either the enterprise or field communication levels.

Design and Coordination Considerations

Design Engineer

All IP Devices must be wired in a star configuration with direct home runs to ASU ET Department provided switches.

For all integrated systems, use BACnet MS/TP, Modbus RTU and other open protocol RS- 485 networks for 3rd tier devices. This would include classrooms, administrative areas, air handling units, 3rd party integrations, zone controllers and any other non-critical controllers. This requirement should be clearly specified in specification Divisions 25 and 23 as applicable and depicted in a network riser diagram in the project drawings.

The use of IP controllers for 3rd tier devices is restricted to critical controllers, plants, clean rooms, life safety, laboratory spaces and 3rd party integrations, unless previously approved by the ASU Facilities Department. This requirement should be clearly specified in specification Divisions 25 and 23 as applicable and depicted in a network riser diagram in the project drawings.

The technology drawings should contain a master list separated by system of all devices requiring an IP connection. These systems shall include but not be limited to Building Automation System, Lighting System, Energy Information System (EIS) or Supervisory Control and Data Acquisition (SCADA) System, Elevator Systems, Fire Alarm Systems, Access Control System, Video Surveillance System and any other system required to operate and monitor the building infrastructure.

General Contractor

During the project phasing planning, the General Contractor should work closely with ASU representatives and subcontractors to identify critical IDF rooms and the necessary pathways for their construction. These IDF closets and the key elements for their completion should be clearly outlined. The completion of these rooms is the main focus of this section.

The IT infrastructure for the BAS and other integrated systems should be in place and operational as soon as practical in the project. Construction and power to IDF closets should be a priority, and should be enclosed and painted with power, lights and air conditioning. This will facilitate all integrations and pre-commissioning activities.

Once the IDF closets are completed, then the Master System Integrator, and other automation subcontractors can coordinate with ASU for installation and commissioning of the network switches for configuration and testing of the automation systems. Network switches and interconnecting copper and fiber for those switches are provided by the ASU ET Department.

Once switches are in the IDF closet, then the IDF closet must be secured with limited access following ASU ET Department access policies.

The general contractor should gather all IP address requests from all vendors installing IP based controls and devices as soon as approved submittals are issued back to the vendors. The IP address request is described above.

Master System Integrators and Automation Contractors

The contractors responsible for installation, programming and commissioning of the building automation systems should be prepared to power up IP controllers as soon as the IDF closet completion occurs.

All required IP addresses should be requested through the project contracting structure from the ASU ET Department as soon as approved submittals are received. The ASU ET Department will provide permanent IP addresses for all the submitted IP controllers.

Structured Cabling Contractor

Ethernet cables for BAS, lighting, elevators, security, fire and other building systems may be needed earlier in the project than other ASU structured cabling. The structured cabling contractor should be prepared to install and test the cables to building IP devices to meet this schedule, and coordinate with the General Contractor and Electrical Contractor as appropriate.

Project Commissioning

Any commissioning and architectural or engineering review of the IDF rooms must be completed, including initial inspections and reporting, before the ASU ET Department installs any equipment.

The commissioning team should refer to the applicable project documents for IDF room requirements.

Arizona State University

ASU should be ready to allocate the necessary IP addresses for building completion early in the project and should have permanent or construction network switches in place by the time the IDF closets are completed. The provided IP addresses will be on the automation-specific VLAN managed by the ASU ET Department.

ASU provided network switches should have interconnecting fiber optics or copper backbone installed so the complete network can begin the configuration and commissioning process.

Section 3 – Controller Requirements

Overview

This document will cover the guidelines for specification and design and installation of controllers for use on the ASU BAS system.

BAS Building Controllers – B-BC

A. BAS Building controllers (B-BC) reside on the Tier 2 network communicating with Internet Protocol (IP) communications. Building controllers collect data from each individual application specific device and can perform supervisory programming based on the collection of all data under its control. This device brings a higher level of decision making that improves the overall performance of a building.

B. Building controllers will be operating the Niagara operating system as produced by Tridium, or an authorized OEM. The operating system shall be at the latest distributed version and accepted by ASU.

C. Controllers and any other devices connected to the BAS network equipment will support the security standard of IEEE 802.1X for port-based Network Access Control.

D. The specifications must contain the following statement to insure an open system.

1. NIAGARA INFORMATION AND CONFORMANCE STATEMENT (NICS) The Niagara
   a. Information
   b. and Conformance Statement (NICS) for all Niagara Software shall allow open

access and be set as follows: accept.station.in=" *" accept. station. out=" *" accept. wb. out="*" accept.wb.in="*". In any case, the end user shall maintain the right to instruct the contractor to modify any software license, regardless of supplier, as desired by the end user. The contractor shall not install any "brand- specific" software, applications or utilities on Niagara Framework-based devices unless accessible by any brand of Niagara tools. All hardware and field-level devices installed shall not be limited in their ability to

c. communicate with a specific brand of Niagara Framework JACE. They shall also be constructed in a modular fashion to permit the next generation and support components to be installed, in replacement of or in parallel with existing components. All controllers must be able to be programmed within the Niagara Workbench. At the completion of the project, the owner shall be given all existing platform and station login credentials to include super user (admin)

d. usernames, passwords and passphrases.

e. The NIC should contain the following line in the license:

f. accept.station.in="*" accept. Station. out="*" accept. wb. out="*" accept.wb.in="*"

E. The building controller will be based on the PC9000 series JACE controllers, and contain all licenses and software required by the application for a fully operable system.

F. No third-party software modules are allowed to be installed on the Niagara system.

G. All alarms will reside in the B-BC and be sent to the Web Supervisor, and to ASU personnel by either text or email.

1. All trends will reside in the B-BC and will be transmitted to the Web supervisor at a predetermined interval. Initial interval setpoint will be 15 minutes.
2. All graphics in the B-BC controller will be available at the Web Supervisor level. These PX pages can be copied from the local controller or the use of victuals and export tagging is allowed.
3. Fully Programmable
   a) Preferred type block programming
4. Open Protocol Support
   a) Building Automation and Control Network (BACnet)
   b) Modbus
   c) Message Queuing Telemetry Transport (MQTT)
5. Microprocessor
   a) Multicore (no single core)
6. Memory
   a) 4 GB
7. IP Port
   a) 100Mbps
   b) 1Gbps
   c) IPv4 / IPv6
8. Security
   a) Secure Boot
   b) Access list

    - c) Firewall
    - d) BACnet Secure Connect (BACnet SC) capable.
    - e) 802.1X
9. Real time clock
10. Battery backup
11. Simple Network Time Protocol (SNTP) time synchronization
12. RS-485 port
    - a) Multiple serial RS-485 capable ports
13. Expansion I/O
    - a) IP
    - b) RS-485
14. Power failure features
    - a) Automatic backup
15. Underwriters Laboratories (UL) certification
16. BACnet Testing Laboratories (BTL) certification.

BAS Advanced Application Controller – B-AAC

A. BAS Advanced application controllers (B-AAC) reside on the Tier 2 network as an IP communicating controller, or on a Tier 3 network communicating with BACnet MS/TP communications. Advanced application controllers are fully programmable, and usually contain built in IO channels for data acquisition. The purpose of an advanced application controller is to fully control a system, or piece of equipment in an independent manner for maximized up time and reliability.

B. Communications:

  1. IP communications are reserved for controllers that are critical to the operation of a campus or building, and can be used on hot water, chilled water, condenser or steam central plants, large air handling units, laboratories and any other application deemed critical by ASU.
     - a. IP Port
       1. 100Mbps
       2. 1Gbps
       3. IPv4/IPv6
     - b. Controllers and any other devices connected to the BAS network equipment shall support the security standard of IEEE 802.1X for port- based Network Access Control.

c. Security
  1. Secure Boot
  2. Access list
  3. Firewall
  4. BACnet SC (capable)
  5. 802.1X

2. MS/TP communications will be used for most control applications.
  a. Security
    1. BACnet SC (capable)

C. The B-AAC shall be capable of operating the connected equipment / system according to sequence of operation as stand-alone, without network connection.

D. The B-AAC shall be fully programmable from an Operator Workstation, and the applications shall remain resident in non-volatile memory within the advanced application controller.

E. The B-AAC shall be microprocessor-based with a maximum program scan rate of 3 seconds. They shall be multi-tasking, multi-user, real-time digital control processors consisting of modular hardware with plug-in enclosed processors, communication controllers and power supplies. Controller size and capability shall be sufficient to fully meet the requirements of this specification, the sequence of operation, and the control points matrix.

F. Each B-AAC shall have sufficient memory to conform to the performance requirements, as specified below, to support its own operating system, databases, and control programs.

G. Power Failure: In the event of the loss of input power, there shall be sufficient reserve power to perform an orderly shut-down of the B-AAC 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 without input power.

1. During a loss of power, the control sequences shall go to the normal system shut- down conditions, unless otherwise specified in a Sequence of Operation.
2. Upon restoration of power, after a minimum off time delay, the B-AAC shall automatically resume full operation without manual intervention through a normal soft-start sequence. Reference Sequence of Operation for additional requirements.
3. Should a B-AAC memory be lost for any reason, the system shall automatically reload the program transparently and without any intervention by building personnel.

H. Building personnel shall have the capability of manually reloading the B-AAC from the operator workstation across intermediary networks.

I. Input Points
  1. Universal inputs shall have a minimum of 12 bit analog-to-digital (A/D) resolution and shall monitor the following analog and binary signals:
    a. Thermistors and RTDs of standard curves
    b. 4-20 mA Sensors
    c. 0-10 VDC Sensors
    d. Dry (Voltage-Free) Contact Closures
    e. Pulse Counter and Accumulation with a maximum frequency of 40 Hz
  2. Inputs shall provide over-voltage and over-current (i.e. short) protection.
  3. Inputs shall provide optional software filtering or signal conditioning to eliminate false signals resulting from input “bouncing.”

J. Output Points
  1. Analog outputs shall have a minimum of 8 bit D/A resolution and shall provide the following control outputs:
    a. 4-20 mA - Sink or Source, capable of sourcing 75mA at 12VDC
    b. 0-10 VDC
    c. Floating type analog outputs are prohibited for valve and actuator applications unless noted otherwise.
  2. Binary outputs shall provide Single Pole Double Throw (SPDT) (Form-C) output contacts rated for 2 amps minimum at 24 VAC. Provide pilot relays when required to meet this requirement. Provide local LED for status indication of each binary output point. Inductive loads shall always be controlled by pilot relays.
  3. Outputs shall provide over-voltage and over-current (i.e. short) protection

K. Fully Programmable
  1. Preferred type block programming

L. Open Protocol Support
  1. BACnet
  2. Modbus
  3. MQTT

M. Microprocessor
  1. Multicore (no single core)

N. Memory
  1. 2 GB

O. Real time clock

P. Battery backup

Q. SNTP time synchronization

R. RS-485 port

S. UL certification

T. BTL certification

BAS Application Specific Controllers – B-ASC

A. BAS Application specific controllers (B-ASC) reside on the Tier 2 network as an IP communicating controller, or on a Tier 3 network communicating with BACnet MS/TP communications. Application specific controllers are fully programmable, and usually contain built in IO channels for data acquisition. The purpose of application specific controllers controller are to fully control a piece of equipment such as a small air handling unit, blower coil unit, fan coil unit or variable air volume terminal in an independent manner for maximized up time and reliability. An application specific controller may have built in pressure sensors, actuators or other built in sensing for the application it was designed to serve.

B. Communications:

  1. IP communications are reserved for controllers that are critical to the operation of a campus or building, and can be used laboratories or other critically controlled zone controls, and any other application deemed critical by ASU.

    a. IP Port

    1. 100Mbps
    2. 1Gbps
    3. IPv4/IPv6

    b. Controllers and any other devices connected to the BAS network equipment shall support the security standard of IEEE 802.1X for port- based Network Access Control.

    c. Security

    1. Secure Boot
    2. Access list
    3. Firewall
    4. BACnet SC (capable)
    5. 802.1X

  2. MSTP communications will be used for most control applications.

    a. Security

    1. BACnet SC (capable)

C. B-ASC shall be capable of operating the connected equipment / system according to sequence of operation as stand-alone, without network connection, operator work station availability, B- AAC, or B-BC availability. It shall be prohibited to distribute control of a single system or equipment across multiple controllers, unless expressly noted otherwise.

D. B-ASC should have built in IO for all points required for operation of the equipment served.

E. The B-ASC shall be fully programmable from an Operator Workstation, and the applications shall remain resident in non-volatile memory within the advanced application controller.

F. B-ASC shall be microprocessor-based with a maximum program scan rate of 3 seconds. They shall be multi-tasking, multi-user, real-time digital control processors consisting of modular hardware with plug-in enclosed

- processors, communication controllers and power supplies. Controller size and capability shall be sufficient to fully meet the requirements of this specification, the sequence of operation, and the control points matrix.

G. Each B-ASC shall have sufficient memory to conform to the performance requirements, as specified below, to support its own operating system, databases, and control programs.

H. Power Failure: In the event of the loss of input power, there shall be sufficient reserve power to perform an orderly shut-down of the B-AAC 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 without input power.

1. During a loss of power, the control sequences shall go to the normal system shut- down conditions, unless otherwise specified in a Sequence of Operation.
2. Upon restoration of power, after a minimum off time delay, the B-AAC shall automatically resume full operation without manual intervention through a normal soft-start sequence. Reference Sequence of Operation for additional requirements.
3. Should a B-AAC memory be lost for any reason, the system shall automatically reload the program transparently and without any intervention by building personnel.

I. Building personnel shall have the capability of manually reloading the B-AAC from the operator workstation across intermediary networks.

J. Input Points

1. Universal inputs shall have a minimum of 12-bit A/D resolution and shall monitor the following analog and binary signals:
    a. Thermistors and RTDs of standard curves
    b. 4-20 mA Sensors
    c. 0-10 VDC Sensors
    d. Dry (Voltage-Free) Contact Closures
    e. Pulse Counter and Accumulation with a maximum frequency of 40 Hz
2. Inputs shall provide over-voltage and over-current (i.e. short) protection.
3. Inputs shall provide optional software filtering or signal conditioning to eliminate false signals resulting from input “bouncing.”

K. Output Points

1. Analog outputs shall have a minimum of 8-bit D/A resolution and shall provide the following control outputs:
    a. 4-20 mA - Sink or Source, capable of sourcing 75mA at 12VDC

- b. 0-10 VDC
- c. Floating type analog outputs are prohibited for valve and actuator applications unless noted otherwise.

2. Binary outputs shall provide SPDT (Form-C) output contacts rated for 2 amps minimum at 24 VAC. Provide pilot relays when required to meet this requirement. Provide local LED for status indication of each binary output point. Inductive loads shall always be controlled by pilot relays.
3. Outputs shall provide over-voltage and over-current (i.e. short) protection.

L. Fully Programmable, or fixed configurable application
  1. Preferred type block programming

M. Open Protocol Support
  1. BACnet
  2. MQTT

N. Microprocessor
  1. Multicore (no single core)

O. Memory
  1. 2 GB

P. Real time clock
Q. Battery backup
R. SNTP time synchronization
S. RS-485 port
T. UL certification
U. BTL certification

Design and Coordination Considerations

Design Engineer

The design engineer will use this section to guide development of the project documents for all building systems including but not limited to Facility Management Systems, Energy Information Systems, Fire Alarm Systems, and Lighting Systems.

Master System Integrators and Automation Contractors

The master system integrator shall be available during the design process to provide advice as to the compatibility of the systems being specified with the current intent of the ASU project guidelines.

Project Commissioning

Analyze project documents for meeting the required intent of the ASU design guidelines and develop a comprehensive commissioning plan to capture all project requirements.

Arizona State University

ASU should be prepared to assist the design and commissioning team with integration of the project guidelines into the project, as well as access to current vendors that are partnering with ASU in the implementation of projects that meet the current ASU design guidelines.

Section 4 – Control Devices

Overview

This chapter will cover the guidelines for specification and design of sensors, output devices and sequences of operation for use in the installation of ASU BAS Systems.

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.

Temperature

A. 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 10,000Ω Thermistor, or two-wire 1000Ω platinum RTD.

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:

B.	Point Type	C.	Accuracy
D.	Chilled Water	E.	±0.5°F.

F.	Room Temp	G.	±0.5°F.
H.	Duct Temperature	I.	±0.5°F.
J.	All Others	K.	±0.75°F.

1. Room Temperature Sensors
    a. Room sensors shall be constructed for either surface or wall box mounting.
    b. Room sensors shall have the following options when specified:
        1. Setpoint adjustment option providing a +3 degree (adjustable) range.
        2. Individual heating/cooling setpoint adjustment options.
        3. A momentary override request push button for activation of after- hours operation.
        4. Analog thermometer
    c. Factory pre-calibrated with non-interactive zero and span adjustments.
    d. High Traffic Public Areas (corridors, lobbies, waiting rooms, vestibules): blank covers without set point adjustment slide switch and override pushbutton.
    e. Mounting on perimeter walls or columns shall be avoided. Where a sensor is mounted on a perimeter wall or column comply with the following.
        1. Perimeter Walls and Columns: installed with a thermally insulated electrical wall box, free of air infiltration from the wall or column cavity. Caulk the cable entrance to avoid drafts.
2. Thermowells
    a. When thermowells are required, the sensor and well shall be supplied as a complete assembly, including well head and flexible conduit fittings.
    b. Thermowells shall be pressure rated and constructed in accordance with the system working pressure.
    c. Thermowells and sensors shall be mounted in a thread let or 1/2” NFT saddle and allow easy access to the sensor for repair or replacement.
    d. Thermowell materials for chilled and hot water shall be brass.
    e. Thermowell material for condenser water and steam shall be 316 stainless steels.
    f. Thermal compound should be applied to the sensor tip and immersion well prior to installation.

3. 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.
    d. Outside air sensors should be installed on the north facing façade of the building, preferably under an awning.

4. 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. Sensor probes shall be constructed of 304 stainless steel.
    c. For outdoor air duct applications, a weatherproof mounting box with weatherproof cover and gasket shall be used.
5. Averaging Sensors
    a. For ductwork greater in any dimension than 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 four sensing points per 12-foot-long segment.
    c. Capillary supports at the sides of the duct shall be provided to support the sensing string.

Carbon Dioxide

A. Carbon Dioxide Sensors

1. Sensors shall adhere to the following guidelines:
    a. Carbon dioxide detector shall employ non-dispersive infrared (NDIR) technology. Sensor range shall be no greater than 0-2000 PPM. Sensor shall be accurate to within + 100 PPM. Alarm setpoint resolution shall be + 20 PPM minimum and operating hysteresis of + 50 PPM.
    b. Sensor shall provide automatic zero compensation and allow user zero and span calibration adjustments.
    c. Sensor shall produce both a dry contact alarm signal and a 0-5 VDC, 0-10 VDC or 4-20 mA proportional signal.
    d. Sensor ambient operating ranges shall be 32 to 122 Deg. F. and 10 to 95% RH non-condensing.
    e. Sensor shall operate on 24 Vdc.
    f. Wall and duct mount carbon dioxide sensor shall be Veris or approved equal. Provide plastic aspiration box model 1501 or 1502 and perforated metal intake tube for all duct mounted sensors. Combination wall sensors are allowed to match the control vendors zone controls.

Humidity

A. 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 be +/- 2% overall accuracy, including lead loss and Analog to Digital conversion. Tighter tolerance may be required in some special use spaces.
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 Seal-Tite 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.

Pressure

A. 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.

Flow

A. 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 directionalizer 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.

4. The static pressure sensing probes (low side) shall be bullet- nosed shaped, per detailed radius, as illustrated in Industrial Ventilation Manual 16th Edition, Page 9-5.
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
   - The maximum allowable pressure loss through the Flow and Static Pressure elements shall not exceed
   - .065” w.c. at 1000 feet per minute, or .23” w.c. at 2000 feet per minute. Each unit shall measure the airflow rate within an accuracy of plus 2% as determined by
   - U.S. – GSA certification tests and shall contain a minimum of one total pressure sensor per 36 square
   - inches of unit measuring area.
   - The units shall have a self-generated sound rating of less than NC40, and the sound level within the duct shall not be amplified nor shall additional sound be generated.
   - Where the stations are installed in insulated ducts, the airflow passage of the station shall be the same size as the inside airflow dimension of the duct. Station flanges shall be two inches to three inches to facilitate matching connecting ductwork.
   - Where control dampers are shown as part of the airflow measuring station, opposed blade precision-controlled volume dampers integral to the station and complete with actuator,
   - pilot positioner, and linkage shall be provided.
   - Stations shall be installed in strict accordance with the manufacturer’s published requirements, and in accordance with ASME Guidelines affecting non- standard approach conditions.
8. Standards
   - Satisfies ASHRAE 62.1 and 189.1 requirements.
   - Listed by BACnet Testing Laboratories for global Building Automation System

b. All meters with BACnet communications shall have BACnet points list and BACnet PICS statement included with the submittal.

c. 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 the 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.

d. All meters with BACnet communications shall have BACnet points list and BACnet PICS statement included with the submittal.

e. All meters with Modbus communications shall have the point register map, and Modbus application manual included with the submittal.

Status and Safety Switches

A. Status and Safety Switches

1. General Requirements

a. Switches shall be provided to monitor equipment status, safety conditions, and generate alarms at the BAS 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. In the case of ECM driven equipment, application specific current sensing switches shall be used.

d. 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

Actuators

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 orbe hard wired to start/stop the associated pump or chiller.

Dampers

A. 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

    a. 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. Blade seals shall be extruded Ethylene Propylene Diene Monomer (EPDM). Seals shall be secured in an integral slot within the aluminum extrusions. 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 Air Movement and Control Association (AMCA) Std. 500.

4. Airfoil 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 jackshaft twist.

Valves

A. 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.

B. Control Valve Selection

1. Modulating 2-way valves 1/2" through 3" shall be either characterized ball or globe valves.
2. Modulating 2-way valves 2" through 6" shall be globe valves with single actuator only.
3. Modulating 3 way mixing valves 1/2" through 2" shall be globe valves only or characterized ball valves designed for mixing.
4. Modulating 3 way diverting valves 1/2" through 2" shall be either characterized ball or globe valves.
5. Modulating 3 way mixing and diverting valves 2 1/2" and larger shall be either globe or butterfly valves with single actuator only.

C. Control Valve Sizing

1. Control valves shall be sized by application as follows:
   - a. Valves (2 or 3-way) for terminal reheat coils, fin tube radiation and radiant panels shall be sized for a 1 to 4 PSI drop, but no more than 5 PSI. Valve flow characteristic shall be equal percentage. The pressure drop shall match the branch pressure drop to provide a minimum of 50% authority. Downsize heating valves when between standard valve sizes.
   - b. Differential pressure bypass valves (2-way) in constant flow pumping systems shall be sized as for 90% the design flow of one pump with a drop equal to the pump head. Valve flow characteristic shall be linear. Valve trim materials and actuator torque shall be selected and rated for this large pressure drop.
   - c. Modulating butterfly valves shall be sized at 60 degrees maximum opening.
   - d. Two position open/closed valves shall be line sized with no appreciable pressure drop.
   - e. Modulating 2-way valves with larger than 6" shall be two ball or globe valves, sized at 1/3 and 2/3 flow.
   - f. Valve manufacturer shall size valves for any nonstandard modulating applications.

D. Control Valves (Pressure Independent)

1. Type: pressure independent, with actuator, delivers a near constant flow rate with rapid system differential pressure changes of more than 1000%.
2. Configuration: one integrated valve body that incorporates one chamber with an adjustable Cv and a separate pressure regulating chamber used to maintain a constant differential pressure across the control surface.
3. Each control valve size and model proposed to be provided on this project shall be individually flow tested at the factory and verified to deviate no more than ±5% at the operating pressures of 5, 35 and 65 PSID at each 10 degree increment. All testing shall be performed with instruments calibrated to the requirements of ANSI/ISA-S75.11- 1985, with traceability to NIST and/or ISO standards.
4. Valve body and trim: ANSI Class 150 rated, ANSI/FCI 70-2 Class III or better leakage rating at 70 PSID, all metal and Teflon internal trim, and designed for 100:1 or better turndown.
5. There shall be three ports installed at the factory integral to each valve and capable of being used to measure pressure or temperature in the field. The first port shall be installed at the inlet to the valve. The second shall be installed between the Cv chamber and the pressure regulating chamber. The third shall be installed at the outlet of the valve. Should the ports not be provided as part of the valve body, then they shall be installed

in a spool piece and attached to the body.

6. The differential pressure between the first and the third port shall be used to verify that the minimum differential pressure of 5 PSID required for pressure independent operation is available.
7. It shall be possible to verify the flow rate through the control valve using the valve stem position and the differential pressure measurement between the first and second ports on the valve. If these valve features are not provided, a flow meter shall be installed at each valve to verify the actual flow rate in operation through the valve.
8. Actuator Connections: 0-10 VDC control signal, 24 VAC power source, and provide a 0-100% position feedback signal.
9. Only one actuator shall be provided on each valve, regardless of valve type.

E. Steam Control Valves – (Globe Valves)

1. Seat, stem, and plug: stainless steel, no exceptions
2. Body (NPS 2 and smaller): ANSI Class 250 bronze body and TFE packing.
3. Body (NPS 2-1/2 and larger): ANSI Class 250 cast iron body and TFE V- ring packing.
4. Characteristic: linear or equal percentage flow characteristic.

F. Ball Valves

1. Ball and stem: stainless steel, no exceptions
2. Body: forged brass or bronze, pressure rating of 400 PSI.
3. Seats and seals: Teflon
4. Shut off: bubble tight shut off at 100 PSID
5. Stem Design: blow-out proof design, packing with minimum of 2 EPDM or Modified Tetrafluoroethylene (MTFE) O-rings, drive adapter shall thermally isolate the actuator from the stem.
6. Characteristic: “deep” equal percentage flow characteristic by any of the following methods: characterizing disc, parabolic port insert or modified cut ball.
7. Modulating valves shall be reduced port to minimize the need for excessive piping reducers. Valve size shall not be three (or more) pipe sizes less than the pipe size. For example, a 1" valve would not be acceptable in a 2" line, but a 1 1/4" valve would be. The Cv calculation shall include pipe reduction effect.
8. Actuator:
    a. Manufacturer shall have ISO 9001 quality certification.
    b. UL 873 listed

c. Plenum rated when installed in an air plenum.

d. Direct coupled, rotational type with visual position indicator and external adjustable stops to limit the travel in either direction.

e. Provides current limiting circuitry or microprocessor overload protection incorporated in its design to prevent damage to the actuator.

f. All actuators fail in the last position unless specified with mechanical spring return in the sequences of operations. Capacitor and battery return actuators are not acceptable. The spring return feature shall permit normally open or normally closed positions of the valves as required. All non-spring return actuators on valves 3/4" and larger shall have a gear release and handle to allow manual positioning.

g. Actuators for modulating valves shall be microprocessor controlled brushless DC motors. Actuators for two position valves may have brush DC motors.

h. Control Signal: 0-10 VDC or 4-20 mA control signal only. Tri-state or floating actuators are not acceptable for modulating valve actuators.

i. Power Supply: accepts 24 VAC, 24 VDC or 120 VAC

G. High Performance Butterfly Valves
H. Valve Performance Requirements: ANSI Class 300 rated
I. Valve Body: fully lugged stainless steel and carbon steel and rated at ANSI 300 pressure rating for hydrostatic requirements. Flanges shall meet ANSI 300 standards. Valve shall permit bidirectional dead-end service at rated pressure without use of a downstream flange.
J. Valve Trim: stainless steel for discs and stems, with both top and bottom alignment bearings for stems.
K. Seats and Seals: Teflon, and suitable for the intended service.
L. Valve Shaft: extended to clear pipe insulation by 2”
M. Actuator: Heavy-Duty Type
N. Isolation Valves: Two-Position Type.

O. Regular Duty Butterfly Valves
P. Valve Performance Requirements: ANSI Class 150 rated, ANSI raised face flanges, ANSI/FCI 70-2 Class IV leakage rating and bi-directional drip-tight shut to rated pressure, rated to 1,700 kPa dead-end service.
Q. Valve Body: fully lugged carbon steel and rated at ANSI 150 pressure rating for hydrostatic requirements. Flanges shall meet ANSI 125 and 150 standards.
R. Valve Trim: stainless steel for discs and stems, with both top and bottom alignment bearings for stems.
S. Seats and Seals: Teflon, and suitable for the intended service.
T. Valve Shaft: extended to clear pipe insulation by 2”
U. Actuator: Heavy-Duty Type
V. Isolation Valves: Two-Position Type

Relays

A. Control Relays.

1. Control Pilot Relays
    - a. DPDT, 3PDT, or 4PDT relays shall be provided, as appropriate for the application.
    - b. Contacts shall be rated for 10 amps at 120VAC.
    - c. Relays shall have an integral indicator light.

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 BAS 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.
5. 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.
6. 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.
2. Cable shall consist of copper conductors not less than No. 18 AWG-stranded.

3. Shall be 2 or 3 conductor twisted cable with a drain wire.
4. Cable shall have a 100% overall shield.
5. Cable shall be plenum-rated.
6. Cable shall meet or exceed National Electrical Code (NEC) voltage rating of 300V.
7. Cable shall be NEC type CMP.
8. Cable shall meet or exceed UL temperature rating of +60°C.
9. 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.
10. 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:
    a. Analog Input Cable .... Yellow
    b. Analog Output Cable .... Tan
    c. Binary Input Cable .... Orange
    d. Binary Output Cable .... Violet
    e. 24 VAC cable..Gray
    f. General Purpose Cable....................... Natural

11. 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.

12. Room Sensor Cabling
    a. Cable shall consist of copper conductors not less than No. 24 AWG.
    b. Shall be multi-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- Communications Multipurpose Cable (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: Allow 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.

Sequences

A. Sequences of operations shall be project specific, comply with ASU standards, and must be approved by ASU Building Automation System Services. Sequences of operations shall comply with ASHRAE 36 Guidelines where applicable. Refer to Chapter 6 in this document.

Scope of Work (Responsibility Matrix)

T = Temperature Control

Contractor M = Mechanical

Contractor

E = Electrical

Contractor O =

Other

System Description	Supplied By	Mounted By	Wired/Piped By
Steam/Hot Water			
Manufacturer supplied controls	O	T	T
Manufacture interlocks			M
Thermowell	T	M	M
Steam/HW Control Valve	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
Variable Frequency Drive (Control)			T
Combustion Air Damper	T	M	T
Chilled Water			
Manufacturer supplied controls	O	T	T
Manufacture interlocks			M
Thermowell	T	M	M
Control Valves	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
Variable Frequency Drive (Control)			T
Refrigerant monitoring system	T	T	

Pump Suction Pressure Sensor	T	M	

Design and Coordination Considerations

Design Engineer

The design engineer will use this section to guide development of the project documents for all building systems including but not limited to Facility Management Systems, Energy Information Systems, Fire Alarm Systems, and Lighting Systems.

Project Commissioning

Analyze project documents for meeting the required intent of the ASU design guidelines, and develop a comprehensive commissioning plan to capture all project requirements.

Arizona State University

ASU should be prepared to assist the design and commissioning team with integration of the project guidelines into the project, as well as access to current vendors that are partnering with ASU in the implementation of projects that meet the current ASU design guidelines.

Section 5 – Energy Information Systems

Overview

This document will cover the guidelines for design and installation within the ASU BAS database.

The ASU Energy Information System (EIS)

Process Guidelines

A. All issues and concerns regarding ASU’s Energy Information System (EIS) should be directed to the EIS Supervisor, a division of ASU’s Facilities Management (FM).

B. Stakeholders of the EIS include, but are not limited to, ASU Facilities Management, Capital Programs Management Group (CPMG), Energy Innovations (EI) and the Global Institute of Sustainability (GIOS).

C. All metering outlined in this document is intended to accurately report back and update ASU’s Energy Information System Campus Metabolism™, and ASU Reliability applications.

Design Guidelines

A. Definitions

1. Energy Information System (EIS): The entire system of meters, hardware, software, and communication protocols that are specifically designed to collect energy data from various sources. At its core, an EIS includes a centrally managed data collection server that initially collects data in 1 minute intervals and then stores that data in 15 minute averages for long-term storage. The EIS system also includes a front end web interface whereby remote users can access, view and trend any and all data that is collected. All associated network routers, switches, fiber, wiring, as well as open system ports, and open protocol bus or integrators are part of this system communications.
2. Campus Metabolism™ is an interactive web tool that enables the user to view the current utility resource use on campus. One can easily choose to view information by individual building, building type, or the entire campus, at different time scales. Campus Metabolism™ was created to highlight the often overlooked and hidden connection between the impact of the actions in our daily lives and the natural world.
3. Control Wiring: Includes conduit, wire and wiring devices to install a complete control and monitoring system which includes system meters. It includes all wiring from a SCADA cabinet to all sensors and points defined in this document. It also includes all necessary power wiring to the SCADA and all EIS devices, meters and cabinets.
4. Data Acquisition System (DAS) or SCADA: Supervisory Control and Data Acquisition. A SCADA unit is a PLC (Programmable Logic Controller) type device designed to collect data points from a variety of sources. It allows for a decentralized collection process whereby data can be collected and stored independent of a central computer. ASU's EIS is built upon the use of stand-alone SCADA units installed in the building. For the purposes of ASU EIS
    - system, the SCADAPack from Schneider Electric is the preferred SCADA unit.(SCADAPack™ 47x | 47xi | Schneider Electric USA (se.com)). Consult with the EIS Supervisor for the specific application.
5. Champ Panel: an enclosure that houses the Schneider Electric SCADA PACK, 24 VDC power supply, fuses, terminal blocks, 8 port network switch with fiber optic converter, and a laptop convenience outlet.
6. Network: A system of distributed devices 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.
7. The term "provide" means "provide complete in place", that is, furnished and installed and ready for operation and use.

B. <u>System Intent</u>

1. The campus Energy Information System and all components of the system is intended to quantify campus energy consumption at various levels of distribution, record all data at 1 minute intervals (15 minutes for long-term

storage), and provide a simple method of data retrieval for energy use evaluation. Quantification of consumption is typically achieved at the building level by metering all utilities being supplied at the building utility entrance. This may include, but is not limited to; electrical, chilled water, steam/hot water, and natural gas. The system is installed to be utilized as a tool to prevent unnecessary energy usage, identify opportunities for reduction of energy consumption, provide analytical information for planning and development of the ASU infrastructure, and assist in achieving ASU's energy goals.

C. When to Install Metering

1. All new building projects on any ASU campus or ASU-owned property shall be required to have EIS metering installed.
2. Any Tenant Improvement (TI) project that adds additional utility service entrance sections that are above and beyond what is already in place and is currently being metered needs to be metered.
3. Any onsite energy generation station that is attached to the load side of the building shall be metered independently. In the case of solar photovoltaic, if the installation is capable of producing more than the building consumes at any given time, the building service entrance meter shall be installed or replaced with a bi-directional meter.
4. Any improvement made external to a building that is not intended to directly service building operation or function, yet receives utilities from the building, shall be metered independently. An example of this would be a cellular tower installed on abuilding.
5. Any renovation that impacts 50% or more of a non-metered building shall require the addition of metering for the utility entrance sections of the entire building.
    a. If the cost of metering totals 20% or more of the total construction cost of the renovation, a variance may be submitted to the ASU Authority Having Jurisdiction (AHJ).

D. EIS at each ASU Campus

1. A SCADA unit shall be installed as follows:
    a. The location of this unit shall be installed in the main equipment room of the building. Exceptions must be submitted and approved in writing by the EIS Supervisor.
    b. Any and all metering for that building will bring its lines of communications back to this SCADA unit through a hard-wired connection.
    c. If a SCADA unit is unavailable, or if pathway of getting the meter data to the SCADA is impossible to define, only then may an alternative use of a Gateway device can be considered. The preferred gateway in these instances is a B&B Electronics Vlinx MESR902.

d. The SCADA unit shall, at a minimum, communicate the following protocols:

1. HART
2. Discrete Binary Inputs/Outputs.
3. Discrete Analog Inputs/Outputs.
4. Modbus RTU (Serial) and TCP.
5. RS232
6. RS485v
7. TCP/IP
8. BACnet – communications are through a gateway in the Champ Panel to the SCADA PACK. BACnet is not native to the SCADA PACK.

e. SCADAPack shall be mounted within the following type of enclosure: NEMA 4 metal cabinet with door clamps and a key lock. The enclosure shall be no smaller than 24" L x 24" W x 6" D.

f. Industry standard din rail mounting system shall be used to mount all devices within the cabinet.

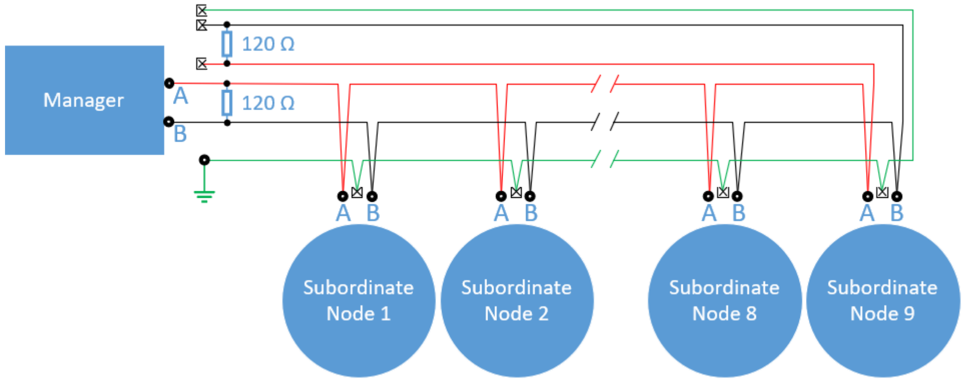
g. The enclosure must have a standard duplex electrical outlet mounted inside of it with a resettable type of circuit breaker of appropriate size. The Enclosure must always be at least feed by emergency power. It is preferred that the panel be fed by the building UPS and backed up by emergency power.

2. The communications standard between meters and the SCADA unit shall be done using a MODBUS RTU or BACnet Serial (RS485) connection.

a. For all Modbus RTU Serial communication, the cabling shall be installed in a LOOP configuration and adhere to the following standards:

1. The Modbus Serial communications loop shall always begin and end at the SCADA unit, without exception. One end will be landed on the SCADA units Modbus serial communications terminals and the other end shall be coiled in the panel. The intent of the Modbus cable returning to the panel is to provide a redundant communication path to the meters or devices as well as point of interconnect to add additional metering in the future on the same Modbus loop.

2.



•

3. Network wiring to be installed using 24 AWG 7/26 Bare Copper – 2 conductors stranded, 7/32 drain wire, characteristic impedance (Zo): 100 to 200 ohms, mutual capacitance <= 12.5 pF/foot @ 1 KHz nominal, capacitance to shield <= 60 pF/foot, propagation velocity
   - >= 60%, UL Type CMP/CL3P 24 AWG.
4. Maximum length is 4000 ft. End of line termination resistor (120 ohm 1/4 watt) to be installed at both ends of network. All communication cabling to be installed in a daisy chain configuration, no T taps are permitted. Shield on communication cable is to remain continuous and ground only at the controller. Polarity of the wires must be observed. Splicing of communications cable is not permitted.
5. Outer jacket insulation rating must meet or exceed NEC Article 300, 310 and Table 310.10
6. Modbus TCP is also an acceptable form of communication between field devices and the SCADA unit.

3. If BACnet communications are required, written approval from ASU’s EIS Supervisor is required. In order to accomplish this, a Field server Quick server Gateway device will be required to translate the BACnet data to Modbus TCP or Modbus RTU. A Copy of the Final Field server Database must be made available upon project completion.

4. HART and Binary inputs are also acceptable and must be installed as accordingly to their manufacturer recommendations.

5. All SCADA units, meters and devices must communicate back to ASU’s centralized servers hosted by ASU’s Facilities Management. Data from these devices and meters shall be programmed through and displayed on ASU’s Energy Information System and Campus Metabolism™ system.

   a. Please contact the EIS Supervisor to receive directions on how to have these systems programmed through. Programming Templates for EIS naming conventions are available.

6. Updates of the data to ASU’s servers will occur as fast as the communication

trunks will allow. Data will then be written to the database every minute for the 1st hour and then rolled up to 15 minute averages for long term storage.

7. Upon the completion of the installation of all meters and devices, verification and certification needs to occur regarding the accuracy of the data that is being metered all the way through to the front end. Formal
    - documentation needs to be presented and submitted to ASU detailing the validity of the meters. All meters shall be revenue grade and within 1% accuracy.

8. Communications for all SCADA units back to the servers shall reside on ASU's Building Controls VLAN, a secure network residing on the backbone of ASU Network infrastructure. Please contact ASU's EIS Supervisor for more details.
    a. The protocol of choice for these communications is Modbus TCP.
    b. For the Tempe campus ONLY, all EIS data must reside on ASU's dedicated EIS Fiber network.
    1. If the EIS fiber does not already exist in the building, it must be installed as part of the project.
        - The fiber needs to be installed back to a central fiber hub building identified by ASU's EIS Supervisor.
        - The fiber shall be 12 strand Multi-Mode 50 micron.
        - Any exposed fiber shall be run in dedicated Blue Inner-Duct to protect the fiber and identification purposes. Otherwise, the fiber can be run in a dedicated conduit that is labeled as EIS fiber. See ASU Project Guidelines for conduit and labeling requirements. No other cabling can be run in this inner duct or conduit pathways.
    c. If an exception from the use of fiber is required, express written approval must be granted by ASU's EIS supervisor.
    1. If approved, only then is the use of ASU's Building Controls VLAN is permissible.

E. <u>Startup and Commissioning</u>

1. Each device requiring an ethernet drop/ connection, must have a Building Network Request Document submitted to ASU.

2. Upon completion of any meter installation, the contractor or an independent third party shall be responsible for commissioning certifying and verifying the accuracy of the installed meter.
    a. The meter shall perform within manufacturer's design specifications.
    b. Written documentation shall be provided to ASU outlining the accuracy of the meter and results of the tests performed.

   c. The meter shall be tested and the methodology used shall be reported, or a statement that the testing is in conformance with the manufacturer's best practices.

3. A one-line diagram showing how the metering was installed and wired as well as labeling important features (such as Modbus ID's) shall be provided at the time of commissioning. The one-line diagram shall show the network wiring between the meters as installed.
4. All field devices and cabling shall also be labeled appropriately as identified in the one- line As-Builts.

Technical Guidelines

A. Electric Metering

B. Building/Facility-level Electric metering shall use Veris meters (http://www.veris.com).

1. Electric metering on all ASU campuses shall be of revenue grade.
2. All communications shall be either Modbus Serial or, if available, Modbus TCP. The Modbus communication loop shall be installed in a loop starting from the SCADAPack to each meter and then back to the SCADAPack.
3. For standard electric metering, the Veris E51 Series Modbus Serial CT meter, which is the enhanced meter, shall be used.
   a. Main service entrance: Veris E51 Series bi-directional meter (or approved equivalent) with Modbus communications.
   b. Sub-breakers: the enhanced Veris E51 Series Modbus Serial CT meter (or approved equivalent).
4. The main EIS meter shall be installed on the load side of the SES before any distribution of the power. From there, metering shall be installed on all SES sub-breakers. Each meter shall be installed with local disconnects so that the meter can be serviced without operating a main disconnect or breaker.
5. The metering needs to be installed with the full intent to capture what is being consumed. For example, if the goal is to capture the load of the building, metering shall occur at each Service Entrance Section (SES) before any distribution of power.
   a. Beyond total building consumption, electric metering needs to be in place to capture ALL mechanical, lighting and plug loads of a facility. For LEED advanced submetering is required if the plug load is more than 10% of the building load.
6. Minimum, the data provided from the meter shall be instantaneous

kW, kWh, Volts per phase, line to neutral per phase, Amps per phase, kVAR, and power factor. Modbus addressing for the Veris meter shall start at ID #7 and proceed from there chronologically on each Modbus serial loop. Each Modbus Comm line is independent of the addressing used in other comm trunks. ID's do not build upon previous trunks and are identified by the trunk number then the id.

7. Modbus ID numbering is as follows:
    a. 1 to 6: Chilled and Hot Water BTU metering and differential pressure.
    b. 7 to 64: Electrical metering
8. All necessary cables, conduit and wire shall be labeled appropriately and installed per code requirements and ASU Project Guidelines.
9. Color Coding shall be as follows:
    a. Building controls Fiber = Blue interduct for identification
    b. Fire Alarm and Protection = Red interduct for identification
    c. UTO Fiber = White interduct for identification.
    d. ET Fiber = White interduct for identification.
10. All distribution-level Electric metering at the medium voltage level shall use the Schweitzer Engineering Lab (SEL) meter (http://www.selinc.com).
    a. Electric metering on all ASU campuses shall be of revenue grade.
    b. All communications shall be either Modbus Serial or, if available, Modbus TCP.
    c. For standard electric metering, the SEL 735 meter shall be used.
    d. The meter shall be installed on the load side of the substation switchgear before any distribution of the power and at the location of circuit protection for all distribution circuits. Each meter shall be installed with local disconnects so that the meter can be services without operating a main disconnect or breaker.
    e. At a minimum, the data provided from the meter shall be instantaneous kW, kWh, Volts per phase, line to neutral per phase, Amps per phase, kVAR, and power factor. Additional power quality data to be captured is harmonics, harmonic distortion, sags, swells, and flicker. The data obtained from the meter shall also include any diagnostic and configuration data available.
    f. Meter shall have local storage of data for network outages.
    g. All necessary cables, conduit and wire shall be labeled appropriately.

C. Chilled and Hot Water Metering

1. All chilled and hot water metering for the ASU EIS system shall use revenue grade BTU meter with ultrasonic clamp-on transducers and

temperature sensors.

a. The Flexim Model F721 Single Channel or F722 Dual Channel Ultrasonic Meter or approved equivalent by the EIS Supervisor are acceptable.

b. All Chilled and Hot water metering on all ASU campuses shall be of revenue grade.

c. All communications shall be either Modbus RTU Serial or, if available, Modbus TCP.

- The Modbus communications loop shall be installed in a loop starting from the SCADAPack to each meter and then back to the SCADAPack.

d. The meter shall be installed to manufacturer's specifications.

e. If current runs of pipe do not meet manufacturer recommendations on how the meter shall be installed, then new pipe may be required to be installed to accommodate.

f. The metering needs to be installed with the full intent to capture what is being consumed. For example, if the goal is to capture the load of the building, then metering at the building entrance needs to occur.

g. At a minimum, the data provided from the meter shall be Supply Temperature (Fahrenheit), Return Temperature (Fahrenheit), Flow (in Gallons per Minute) Totalized BTUs, and instantaneous kBTU's. Additional diagnostic data from the BTU meter is also preferred.

h. Modbus addressing for the meter shall start at ID #1 and proceed from there chronologically to ID #6 on each Modbus serial loop.

i. Differential Pressure (DP) sensor shall be required to be installed at the building entrance on the CHW system. The DP sensor shall be Rosemount 3051MV no substitutes, and installed on the primary or district side of the heat exchanger. The DP sensor shall tie back to the local SCADA unit through Modbus communications.

j. All necessary cable, conduit and wire shall be labeled appropriately and installed per code requirements and ASU Project Guidelines.

D. Domestic Hot and Cold Water Metering

1. All domestic water metering for the ASU EIS system shall use revenue grade flow meters with ultrasonic clamp-on transducers.

2. The Flexim F532 Ultrasonic Meter or approved equivalent by the EIS Supervisor are acceptable.

3. Accuracy of the meter shall be no less than:

a. ±1-1/2% GPM full scale.

   b. Low flow should be 5% of gpm rating.

4. All communications shall be either Modbus RTU Serial or, if available, Modbus TCP.
   a. The Modbus communications loop shall be installed in a loop starting from the SCADAPack to each meter and then back to the SCADAPack.
5. The meter shall be installed to manufacturer’s specifications.
6. If current runs of pipe do not meet manufacturer recommendations on how the meter shall be installed, then new pipe may be required to be installed to accommodate.
7. The metering needs to be installed with the full intent to capture what is being consumed. For example, if the goal is to capture the total domestic water flow of the building, then metering at the building entrance needs to occur.
8. The domestic water and irrigation flow meters shall be mounted in such a way that a building shutdown shall not be required to service the meter whenever possible.
9. At a minimum, the data provided from the meter shall be Instantaneous Flow (in Gallons per Minute) Totalized Flow, and Flow Rate (GPH). Additional diagnostic data from the BTU meter is also preferred.
10. Modbus addressing for the meter shall start at ID #1 and proceed from there chronologically to ID #6 on each Modbus serial loop.
11. The use of domestic water for landscaping shall be metered separately.
12. All necessary cable, conduit and wire shall be labeled appropriately and installed per code requirements and ASU Project Guidelines.

E. Steam Metering

1. All Steam metering shall use revenue grade BTU meters.
   a. Siemens Sitrans FX300 Vortex or Rosemount 8800 flanged vortex flow meter;

however, there may be instances where an orifice plate meter needs to be installed instead. Please consult the ASU EIS Supervisor for verification or approval of acceptable alternative. Steam metering on all ASU campuses shall be revenue grade.

   b. Communications for this meter is currently HART which is acceptable. If Modbus Serial or TCP are available, these forms of communications are preferred.
   c. The meter shall be installed to manufacturer's specifications.
   d. A condensate trap shall be installed inline before each steam meter.
   e. Steam meter size calculations shall be provided by the project engineer with final acceptance and approval of ASU.

   f. At a minimum, the data provided from the meter shall be Supply Temp (Fahrenheit), Pressure (psig), Flow (lb/hr) and instantaneous kBTU's. If possible, the temperature of the condensate return is also desired.
   g. If current runs of pipe do not meet manufacturer recommendations on how the meter shall be installed, then new pipe shall be required to be installed to accommodate.
   h. All necessary cables, conduit and wire shall be labeled appropriately and installed per code requirements and ASU Project Guidelines.

F. Renewable Energy Systems Metering

1. For all solar photovoltaic and wind producing electrical systems, metering shall follow the same specifications and guidelines as described in the Electrical Metering section of ASU's EIS Guidelines.
   a. The meter shall be installed directly after the inverter in order to capture the actual amount of power produced from the system.
2. For all solar thermal and water-based systems, metering shall follow the same specs and guidelines as described in the Chilled and Hot water metering section.
3. All necessary cable, conduit and wire shall be labeled appropriately and installed per code requirements and ASU Project Guidelines.

G. Additional Metering

1. Any additional metering for the EIS and/or CM applications may be required as well as requested from either CPMG, FACMAN and/or the Energy Innovations group.
2. Examples of additional metering that may be required include but are not limited to:
   a. Gas
   b. Grey Water
   c. Carbon
3. The need for additional metering shall be determined by ASU's EIS Supervisor.
4. Any additional metering must meet manufacturer's recommendations on installation.
5. Must be revenue grade unless express written consent is given by ASU's EIS Supervisor.
6. Must follow ASU's Sustainability Guidelines.
7. All necessary cables, conduit and wire shall be labeled appropriately and installed per code requirements and ASU Project Guidelines.

H. Programming

1. All programming of the main SCADA unit shall be completed by the provider of the SCADA unit and shall meet the requirements and specifications outlined by ASU's EIS Supervisor at the time of the install. ASU may obtain the services of a 3rd party Owners Representative to verify field programming has been completed to ASU standards.
2. All IP addresses for the SCADA unit or any field device shall be provided by the ASU ET Department .
3. All programming of the data acquisition from the SCADA unit by ASU's centralized EIS servers shall be performed by ASU's EIS personnel.
4. Any additional programming of the EIS and/or CM graphical front end needs to be coordinated through ASU's partner who helps maintain these sites. Any costs associated with the changes or updates need to be paid for by the project.
   a. Please see the ASU EIS Supervisor for this contact information.

I. ASU Electrical Reliability Monitoring (per ASU's Reliability).

1. Provide digital metering at overcurrent protective devices for campus medium voltage loops, for main panel-boards 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).
2. Provide monitoring of each transfer switch for status and position of switch, and report back through the EIS network to the ASU Reliability system located at the ASU Central Plant. Integration through Modbus RTU to the EIS is the preferred method of monitoring automatic transfer switches. Use of a contact in the automatic transfer switch wired to the closest SCADAPack is allowed where Modbus is not available. Photo- optic Isolation required if contact is used.
3. Provide monitoring through a Modbus (RTU Serial or TCP) interface from each Generator for status, load, and alarms, and report to the closest SCADAPack which will report back through the EIS network to the ASU Reliability system located at the ASU Central Plant. The system shall provide automatic notification to Central Plant and FACMAN operations when emergency and critical loads are transferred to the standby generator source.
   a. Alarms shall be distributed to campus facilities and personnel based on the requirements of each building as defined by the ASU EIS Department and campus facilities team.
4. Provide fault indicators for each feeder at points of termination into

Medium Voltage switchgear including Kearney switches, with the exception of radial feeds associated with individual building transformers.

Fault indicators shall report to the closest SCADAPack which will report back through the EIS network to the ASU Reliability system located at the ASU Central Plant.

5. Once installed, the system will be commissioned and independently verified that all points report and are shown properly on the ASU Reliability application.
6. Update of Campus Distribution System One-Line and Model so that it is properly represented on the ASU Reliability application.
   a. For each new project involving modifications to the medium voltage distribution, including building transformers, update the campus medium-voltage system one-line diagram and distribution site plan.
   b. For each new project involving modifications to the medium voltage distribution, including building transformers, update the campus electrical design analysis software model for load flow, fault currents and coordination. Presently the analysis software used is SKM Powertools. This update shall be provided by the ASU designated Reliability SCADA Coordinator.
   c. For each new project involving Generators or ATS(s), update the campus Emergency Distribution diagram and distribution site plan.
   d. For each new project involving modifications to the medium voltage distribution including building transformers, and/or Emergency distribution, including local generators and ATS(s), update the ASU Reliability Application to include all new reliability and redundancy items. This update shall be provided by the ASU designated Reliability SCADA Coordinator.

Design and Coordination Considerations

Design Engineer

For all EIS integrated systems, Modbus TCP, Modbus RTU, or Hart. This would include all meter types, and electrical gear and equipment monitoring. This requirement should be clearly specified in specification Divisions 25 and 26 as applicable and depicted in a network riser diagram in the project drawings.

A network “Air Gap” is required between any 3rd party Ethernet communications and the ASU Ethernet network. This is achieved by adding a gateway that converts communications from Ethernet to Modbus RTU. All devices of this type must be declared, reviewed, approved and documented by ASU.

A one-line diagram of the system and network riser diagram of all metering should be included in the project drawings.

General Contractor

The IT infrastructure for the EIS and other integrated systems should be in place and operational as soon as practical in the project. Construction and power to IDF closets should be a priority, and should be enclosed and painted with power, lights and air conditioning. This will facilitate all integrations and pre-commissioning activities.

Once the IDF closets are completed, then the Master System Integrator, and other automation subcontractors can coordinate with ASU for installation and commissioning of the network switches for configuration and testing of the automation systems. Network switches and interconnecting copper and fiber for those switches are provided by the ASU ET Department.

Master System Integrators and Automation Contractors

Contractors should closely coordinate all products provided, and their installation locations and requirements with the general contractor, subcontractors, ASU Facilities Department and the ASU EIS Department during the submittal phase of the project.

Arizona State University

ASU should be prepared to coordinate with system integrators to ensure proper naming, trending and tagging for seamless integration into the existing EIS system.

Chapter 6 – Sequences, Integration and Programming

Overview

This document will cover the guidelines for design and installation of sequences of operation and integrations. This is not an exhaustive list and should be tailored to the individual building design requirements.

Sequences of Operation

Heating Ventilating and Air Conditioning (HVAC)

Sequences of operations shall be project specific, comply with ASU standards, and must be approved by ASU Building Automation System Services. Sequences of operations shall comply with ASHRAE 36 Guidelines where applicable.

The following sequences are not intended to be an exhaustive list of required sequences, but to reflect some standard sequences that are desired in ASU systems, and to provide insight into the design philosophy of ASU buildings.

Energy Saving Strategies

All variable volume systems should implement trim and response setpoint reset strategies that react to the actual demand and load of the system. Reset strategy control sequence of operations shall be in compliance with ASHRAE 36 Guidelines and define coordination between pressure and temperature reset strategies. These resets include but are not limited to the following:

A. Variable air volume air handling unit supply static pressure reset based on terminal unit damper positions.
B. Variable air volume air handling unit supply air temperature setpoint reset based on desired return air setpoint or critical zone reset, or return temperature, and coordinated with the system static pressure setpoint reset strategy.
C. Chilled and hot water system differential pressure setpoint reset based on critical zone valve position.
D. Chilled and hot water supply temperature setpoint reset based on critical zone valve position and coordinated with the system differential pressure setpoint reset strategy.
E. Condenser water supply temperature setpoints based on outside air wet bulb or temperature, and tower performance.
F. Air handling units should be designed with minimum outside air control dampers and be designed to use an economized mode for cooling. Where having a minimum outside air damper is not practical, the outside air damper should control to the minimum design outside air flow when the air unit is not in economizer.
G. Economizer mode shall be enabled based on comparative enthalpy. When the indoor enthalpy is below the outdoor enthalpy, the economizer mode should be enabled.
H. There should be an economizer dry bulb temperate lockout setpoint that prevents economizer operation when the outdoor dry bulb temperature exceeds proper economizer operation.
I. Fans and pumps shall be designed and controlled in a manner that runs them in parallel for optimum energy savings when running at speeds above 85%. (i.e. fan wall systems, and parallel supply pumps).
J. Return fan speed shall modulate to maintain positive space differential set point and/or maintain mixed air static setpoint at slightly negative.
K. Relief fan speed shall be controlled to maintain slightly positive building pressure.
L. In buildings with hot water or steam boiler reheat, there should be a heating disable signal sent to all zone units with heating valves, when the heating system is not heating and pumping water. This signal should disable all heating functions in the building. This includes closing all valves and disabling modulation, disabling variable air volume reheat units from indexing up to reheat flow when the space is below heating setpoint to prevent overcooling.
M. Fan coil units and fan powered boxes should be designed to have modulating fans if feasible, however at a minimum the motors

should have 3 commendable speeds from the BAS for power consumption reduction during standby or low load times.

Scheduling

The Building Automation System (BAS) shall control the HVAC, lighting, and other building systems based on a predefined occupancy schedule. The system shall include provisions to incorporate a standard holiday schedule to override normal operation during holidays.

Use intelligent optimal start/stop (OSS) schedules to start building mechanical systems. The OSS schedules should supplement a schedule that starts the building systems at the normal opening and closing times. Outside air dampers should remain closed during optimum start time until the actual building occupied time.

The BAS shall allow for the programming of a Holiday Schedule that includes a list of pre-defined holidays (e.g., New Year's Day, Independence Day, Thanksgiving,

Christmas), and The Holiday Schedule shall allow for customization to account for observed holidays that may vary year by year (e.g., floating holidays such as Labor Day or local holidays).

Air handling unit systems should implement morning warm-up and cool-down sequences in addition to OSS schedules.

Zones should be grouped together by use, for instance by floor, or public/back office, and have a group schedule assigned to them. Some zones may require and individual schedule for a large conference room, auditorium or event hall. All zones scheduled should be disabled by the time schedule and the OSS schedule for the zones parent air handling unit.

Scheduling shall be coordinated to use the following philosophy of operation:

- **Non-Operating Days:** On the days marked as holidays, the BAS shall revert the building systems to **Unoccupied Mode**, unless otherwise specified. This includes:
  - **HVAC Systems:** HVAC units shall be turned off or operated at a setback temperature to minimize energy consumption while maintaining equipment safety.
  - **Lighting Systems:** All non-emergency lighting shall be turned off.
  - **Exhaust Fans and Air Handling Units:** Shall be disabled or operated at minimum speed.
- **Exceptions:** Critical areas (such as server rooms, labs, or other sensitive areas) shall maintain normal operation regardless of holiday schedules.
- **Manual Override:**
  - Authorized personnel shall have the ability to override the

Holiday Schedule in case of special events or changes in occupancy.

Zone Controls

All zone controls for occupied spaces should utilize motion detection, people counters or other occupancy sensors to select between occupied mode and standby mode.

- During occupied mode the zone space set points shall be as follows:
  - Cooling setpoint: Default 75°F
  - Heating setpoint: Default 70°F
  - CFM setpoint (if applicable): Modulates between design minimum and design maximum
- During standby mode the zone space setpoints shall be as follows:
  - Standby Cooling Set point (2° above Base Room Set Point Default 77 °F)
  - Standby Heating Set point (2° below Base Room Set Point: Default 68 °F)
  - CFM setpoint: Modulates between closed damper position and design maximum CFM as required to maintain the unoccupied setpoints.

During standby mode enough zones must have flow to account for the exhaust in the building to maintain a positive pressure. The BAS should track the additive current flow of all variable air volume terminals and reassign standby minimum flow setpoints as required.

- During unoccupied mode the zone space setpoints shall be as follows:
  - Unoccupied Cooling Set point (Default 82 °F)
  - Unoccupied Heating Set point (Default 60 °F)
  - CFM setpoint: Modulates between closed damper position and design maximum CFM as required to maintain the unoccupied setpoints.

Standby mode shall be defined as when the space is occupied per the occupancy schedule, but the occupancy sensors detect that no occupants are in the space, the relaxed mode of operation shall be set. The heating and cooling temperature set points shall be relaxed by 2 °F from base set point.} The minimum CFM setpoint shall be 0 CFM unless air flow is required to provide heating or cooling needed to meet the relaxed temperature setpoints, or for space ventilation requirements.

Use appropriate combinations of occupancy sensors, people counters and CO2 sensors to perform demand control ventilation adjustment of zone minimum air flow setpoints

Miscellaneous

Provide Air Handling Unit filter bank differential pressure sensor to alarm BAS Workstation when set point is exceeded.

Lighting

Lighting systems should use automated scheduling, and occupancy detection sensors to lower energy consumption to the greatest extent possible. Exterior lights

should use a solar compensated time schedule to compensate for weather.

Interior lighting systems shall utilize daylight harvesting sequences, as well as coordinating with shade controls where appropriate.

Lighting systems shall perform demand response by diming or turning off zones during peak energy demand periods as prioritized by ASU Facilities.

The following table provides a generalized guideline for application of lighting controls

		Corridor	**Lobby**	**Open Office > 250sq.ft.**	**Private Office < 250sq.ft.**	**Restroom**	**Stairwell**	**General Exterior**
Automatic Control	Timeclock	x	x					x
	Occupancy [auto-on / auto-off]	x	x	x		x	x	
	Vacancy [manual-on / auto-off]				x			
Manual Control	Local Dimming or Scene Control		x	x	x	x		
Additional Energy Efficiecies	Daylight Harvesting [>150W]	x	x	x	x			
	Receptacle Control [Timeclock or Occupant Sensor]			x	x			
Programming Notes		Timeclock sweep on, occupancy sensors engage at close of business					Auto-on to 100%, Auto-Dim to 50%	

Where demand limiting strategies are utilized, the following is a list of suggested automated dimming levels during the demand response event

Building Area	Dimming %
Lobby	20%
Corridors	20%
Breakrooms/Cafeterias	20%
Open Offices	20%
Private Offices	20%
Conference Rooms	20%
Classrooms	20%

System Integrations

HVAC

The building HVAC systems shall be integrated into the BAS to provide operation and control.

Lighting

Lighting systems should be integrated to the BAS with a combination of BACnet communication and hardware inputs and outputs as appropriate. At a minimum, the lighting integration will provide the following:

- Time schedules shall be shared between the BAS and the Lighting control system for schedule coordination.
- BAS shall trend performance of daylighting controls, demand limiting sequences and solar compensated time schedules.
- Occupancy sensors status shall be shared either by integrated communications or auxiliary contacts to avoid procurement of redundant occupancy sensors.

Energy Information Systems

The energy information systems shall integrate to the BAS with either BACnet or Modbus communications as appropriate and provide the following services.

The BAS shall provide VFD, equipment energy data and plug load data to the EIS as determined by the ASU Energy Services Department.

- The EIS shall provide power usage and demand data to the BAS for trending.
- The BAS will provide histogram trends of current daily usage against the following historical data. For example:
    - Current day usage against previous day usage
    - Current day usage against same day usage of the previous week.
    - Current day usage against the same day usage of the previous year.
- Peak demand from the EIS shall be used for demand limiting and load shedding sequences.
- The BAS shall monitor and trend energy use against benchmarking standards.

- The EIS/BAS shall plot current energy use against a regression curve of the last three years energy data.
- The building operator shall have a dashboard showing plug loads and their respective percentages of load.

Domestic Water Systems

The domestic water equipment shall integrate to the BAS to provide the following information from either BACnet, Modbus or hardwired points.

- Operation and status of any automated equipment.
- Domestic water supply flow.
- Domestic hot water flow, supply temperature and return temperature.
- Domestic cold water supply temperature.
- Time schedules shall be shared from the BAS to the domestic water system for unoccupied shutdown of domestic water heating recirculation system pump.

Fire Alarm

The fire alarm system shall provide a hardware contact representing the general alarm state of the building, and fire alarm panel trouble status. There shall be one of each type of contact provided to the BAS for each building.

Programming

The preferred programming style of ASU is block programming. And the following guidelines should be followed to provide seamless integration of the building systems.

- All programming should be done in wire sheet form using factory block programming.
- All programming should be easy to decipher and arranged in a neat and organized layout to assist in future readability and serviceability of the system.
- Peer to peer value passing shall be used as much as possible to optimize system communications.
- The use of custom block programs should be kept to a minimum, only being used for complex sequences, if needed.
- The use of non-factory provided programming modules, without prior consent by ASU Building Automation System Services, is prohibited.
- Field level program sheets should always be backed up to the parent building controller.
- Field level program sheets should be named to match the controller that the program resides on. If multiple controllers use the same program sheet, the name should match the type.
- The use of the same program sheet for multiple, similar controllers is the preferred method, if possible, to assist in future serviceability of the system.
- When programming in BACnet, the proper use of BACnet priority arrays is required.

Submittals

During the submittal phase all integrated points lists, BACnet PICS statements, Modbus integration specifications and wiring diagrams shall be submitted with the specific contacts, points and equipment options provided clearly marked.

Construction

During construction, all sequences of operation will be simulated and demonstrated to the commissioning team and ASU Facilities staff.

Commissioning

Programmers involved in implementation of the sequences of operation and integrations shall be available at the commissioning agent's discretion for the testing and commissioning of the building systems.

Governing Code Compliance

The contractors and designers shall comply with all current governing codes ordinances and regulations, including ASHRAE, UL, NFPA, the local Building/Fire Code, NEC, and so forth.

Design and Coordination Considerations

Design Engineer

The design engineer will use this section to guide development of the project documents for all building systems including but not limited to Facility Management Systems, Energy Information Systems, Fire Alarm Systems, and Lighting Systems.

Master System Integrators and Automation Contractors

The master system integrator shall be available during the design process to provide advice as to the compatibility of the systems being specified with the current intent of the ASU project guidelines.

Automation contractors shall begin collaboration and mock-up testing prior to the beginning of installation of the automation systems.

All integrations will be fully implemented and functionally tested prior to commissioning.

Project Commissioning

Analyze project documents for meeting the required intent of the ASU design guidelines and develop a comprehensive commissioning plan to capture all project requirements.

Arizona State University

ASU should be prepared to assist the design and commissioning team with integration of the project guidelines into the project, as well as access to current vendors that are partnering with ASU in the implementation of projects that meet the current ASU design guidelines.

Section 7 – BAS Naming Standards

Overview

ASU has adopted a standard naming scheme. The following is a breakdown of that naming schema.

Controller Naming Convention

All Controllers will be named according to the naming convention described below. Any variances should be discussed and approved by ASU Facilities Management.

Tier 1 Naming Convention

1. The Supervisory Building Controller device name will consist of three parts:
    - i) A maximum of 12 characters with a number-letter combination consisting of only the following characters: A-Z, a-z, 0-9 and underscore (_).
    - ii) The first part will identify the campus that the controller is a part of. Campus I.D.s can be found here: "https://fdm-apps.asu.edu/UFRM/CDS/".
    - iii) The second part will identify the facility that the controller is located in. Facility I.D.s can be found here: "https://fdm-apps.asu.edu/UFRM/FDS/".
    - iv) The third part will be a unique number identifier signifying which number, out of the total supervisor controllers, this one is. For example: 01, 02, 10.
    - v) The resulting supervisor controller name is a unique device name across the entire portfolio. For example: Tempe Campus, B of A at the Brickyard Facility, Supervisor Controller 01 equals a unique device name of: MC_R10A_01.

Tier 2 and 3 Naming Convention

1. Every controller on the BMS system must have a unique **Device Name** which consists of the following:
    - a. A maximum of 10 characters with a number-letter combination consisting of only the following characters A-Z, a-z, 0-9. The underscore (_) is only to be used in certain scenarios. See below.

The device name and software programmed name are to match. For example, when doing a BACnet device discovery on the network, the BACnet device name matches the supervisory logic device name.

- b. The device name is to be clear and concise, and based on the equipment number if possible.
- c. Equipment numbers will also be utilized to group equipment by type. For instance, all air handling units in a building will be numbered consecutively, and named AHUxx regardless of the application. The same will be true with fans. All exhaust fans will be EFxx regardless of application.
- d. Equipment names used in controller names will correspond to the project documents, for easy cross reference.

e. The underscore is only to be used in differentiating between floor or sub system numbering, like in the case of variable air volume units. For example, a VAV that is served by Ahu01 and serving office 305, would be named Vav01_305.

f. Example device names: Ahu01, Blr11, Chlr07, Fcu35, Vav01_305

The combination of the tier 1, 2, and 3 naming convention provides unique identifiers for each controller to be represented on the portfolio. These identifiers often combine in the form of a location path in reports, and messages from the system similar to file paths in our computer file explorer. If you combine our previous Tier 1 naming example with the VAV naming example from above in this format, it will appear as MC_R10A_01/Vav01_305. From this we now know that this VAV controls the room 305 and is served by AHU01 in the B or A at the Brickyard facility on the Tempe campus and is reporting to the first supervisor controller in the building.

Room Number

Assigned according to room number on building plans. Maximum 5 characters. These room numbers should be established early in the design process, and be consistent between the project documents, BAS naming conventions, and architectural signage installed in the building.

Controller Assignments

Equipment device names

- Names will consist of the following:
  - Short name for piece of equipment being represented as defined in the point naming document "*GSA Data Normalization for Building Automation Systems*" .
  - This name or acronym shall always come first.
  - The number character designation will follow with no space or underscore. Examples:
    - Ahu02, Chlr04, Blr06, Fcu48,

Ef109 Terminal device names

- Names will consist of the equipment device name followed by its number of the master equipment number. This name will be formed as follows:
  - The equipment type: Vav
  - ###, the number representing the AHU serving this VAV: Vav01
  - Underscore (_), this is one of the times where a non-alpha numeric character is all right to use.
  - ###, the room or designation number assigned to the VAV on the building plans. Examples:
    - Vav02_102 means:
      - VAV 102 is served by AHU02 and is located on the first-floor room 102 and is Terminal Unit 102.
    - Sav04_203 means:
      - Supply Air Valve SAV 203 is served by AHU04 and is

located on the second-floor room 203 and Terminal unit 203

Point Naming Convention

Naming of points will be accomplished by use of the ASU approved point naming conventions provided in the file "*GSA Data Normalization for Building Automation Systems*".

In the event that a required point name does not exist, that point will be named using the conventions observed in the "*GSA Data Normalization for Building Automation Systems*" document and approved by the ASU Facilities Team. All new points will be added to the Master List file used in the Brick Schema and provided to ASU as part of project close out documentation.

The point naming convention, not to be confused with Brick Schema, is in place to provide consistent results across the whole portfolio and seamless transition from system to system by the facilities staff. The point naming scheme is a very important building block for a cohesive BAS system. A point naming standard, although separate from Brick, directly impacts it's implementation. Refer to the Brick and tagging documentation.

1. Basic point naming structure
    a. Point names should be Camel Case and use the standard alphanumeric characters only. A-Z, a-z, 0-9. The underscore (_) is not needed in point names, and its use should be avoided.
    b. Point names should always end with the appropriate suffix that defines the points purpose. Cmd, Ena, Sts, Sp, etc
    c. Point names should be concise, yet descriptive following the GSA point naming standards. Supply fan command, SfCmd, boiler enable, Blr01Ena, Supply air temperature setpoint SATmpSp

Number designations will be consistent in their placement, in between the point name and suffix. Supply fan 1 command, Sf01Cmd, Boiler 5 enable, Blr05Ena, Chilled water pump 3 status, ChwPmp03Sts

Design and Coordination Considerations

Design Engineer

The design engineer will specify that all building systems including but not limited to Facility Management Systems, shall use the ASU point naming guidelines. Room numbers, and their associated architectural signage should be established as soon as practical in the project so that naming can be applied in the project documents and match the resulting signage after project completion.

Master System Integrators and Automation Contractors

Comply with all approved ASU naming conventions. At the time of this document, the only approved naming convention follows the "GSA Data Normalization for Building Automation Systems".

Engage ASU when a deviation to the naming system is encountered.

Provide a demonstration of proper naming and folder structures to the commissioning team and ASU prior to deployment.

Add any new names created for the project to the Master List file used in the Brick Schema.

Project Commissioning

Inspect the operating database during pre-installation demonstration and during commissioning to verify compliance with the naming standards.

Arizona State University

ASU should be prepared to assist the contracting team and commissioning team with any non-standard names encountered, and to witness the pre-installation demonstration as well as commissioning activities.

Section 8 – Metadata Tagging

Overview

This document will cover the intent of the ASU Meta Data Tagging strategy. The strategy will be based on the Bricks Ontology and may be implemented in the BAS or used as a guide for tagging. All points and devices will be tagged to allow for future application of building analytics, trending, asset tracking, responsive graphics, and advanced search routines.

The Brick Schema is an open-source project with the goal of standardizing semantic descriptions and metadata of the physical, logical and virtual assets in buildings and the relationships between them.

More information on the Bricks Ontology and its implementation can be found at https://brickschema.org.

The tagging shall be organized using the following descriptions as a framework, with individual applications of tagging chosen from the class definitions found at https://brickschema.org/ontology.

Implementation

The implementation of Brick schema is for point tagging and creating relationships between all things in a building.

The use of tag and relation rules will be required and verified. This will create and maintain a library, starting at the first project and growing. As the system grows, new projects will add new rules that do not already exist. Rules are not to be altered after the first version, just added to. Point name and folder structure standards are to be strictly adhered to.

The rules should be for automatically implementing relations and point tags following Brick schema on any new point added to the ASU portfolio.

This is all accomplished by first starting with standard point naming and folder structure.

By having a standard point naming scheme:

Rules for tag groups are written to be applied automatically to a point name matching that rule currently or new point name added in the future.

When the naming is all the same, there is only one rule per specific point name.

By having standard folder structure:

Rules for relations are written to be applied automatically to devices and points relative to their spot in the folder structure.

When the structure is all the same, there is only one rule per specific relation.

Location Tagging

Each system shall use a tiered system of tagging denoting each level of the location. These tags and usage information are listed in the Location Class in the Bricks documentation.

Region: A tag corresponding to the regional division and organization of ASU campuses will be defined by the campus ID system. Campus I.D.s can be found here: "https://fdm- apps.asu.edu/UFRM/CDS/". Examples:

- Tempe Campus = MC
- Polytechnic Campus = EC
- Downtown Phoenix Campus = DT
- West Valley Campus = WC
- Lake Havasu = LH
- Macro Technology Works = RP
- Camp Tontozona = TZ
- Community Services = CS
- Health Futures Center = HF
- Phoenix Municipal = PM
- Research Park = RP
- Off Site = OC

Site: A tag corresponding to the site will be used to identify and track the building type, and be chosen from the following list:

- Library
- Academic
- Business School
- Student Center
- Research
- Gym
- Dining
- Athletic
- Performing Arts
- Residence
- Parking
- Classroom
- Lab
- Utilities

Administration

- Health Services
- Student Services
- Warehouse
- Arena
- Stadium

Facility: A tag with the facility identifier chosen by ASU campus for identification of an individual building within a site. The building name must be coordinated with ASU Facilities Management, but a list of examples follows here. Facility IDs may be looked up here: "https://fdm- apps.asu.edu/UFRM/FDS/".

- Hayden Library = 010
- Coor Hall = 065
- McCord Hall = 040D
- B of A at Brickyard = R10A

Floor: A tag corresponding to the floor within an individual building. Special tags denoting floor for **Basement, Rooftop,** and **Parking Level** may also be used in lieu of or in addition to the floor number. **Ground Floor** may be used in substitution for 1st Floor or Basement depending on building configuration or Owner preference. Tags will be of the form number underscore floor.

i.e. **1st_Floor**

Room: The room identifier in common use as identified by the signage in the building. i.e. Office 2103, Breakroom 103

Outside: A special tag for denoting cooling towers, chillers, air handlers or other equipment that is physically located outside a building, but not associated with a Floor or Room tag.

Zone: A tag connecting rooms with the HVAC zoning of the area. A zone can be one or more rooms as defined by the mechanical HVAC plans for the building.

System Tags

Each system shall use a tag to identify its building system membership. These tags and usage information are listed in the Collection Class in the Bricks documentation.

Air_System: A tag corresponding to all systems on the air side of the HVAC system except for ventilation systems.

Ventilation_Air_System: A tag corresponding to all systems on the air side of the HVAC system that provide or process air exclusively for the ventilation of the building.

Chilled_Water_System: A tag corresponding to all systems attached to the HVAC Chilled Water system system.

Hot_Water_System: A tag corresponding to all systems attached to the HVAC Heating Water system.

Steam_System: A tag corresponding to all systems attached to the HVAC Steam Supply system.

Domestic_Hot_Water_System: A tag corresponding to all systems attached to the Domestic Heating Water system.

Electrical_System: A tag corresponding to all systems that service the electrical infrastructure of the building.

Gas_System: A tag corresponding to all systems that directly utilize natural gas or other combustible fuels.

Lighting_System: A tag corresponding to all systems that serve either indoor or outdoor lighting.

Equipment Tags

Each piece of equipment shall use a tag to identify the equipment type. This section describes the most common tags used, and the Bricks documentation should be referenced for tags not found in this list. These tags and usage information are listed in the Equipment Class in the Bricks documentation.

- AHU
- **Bypass_Valve**
- **Chiller**
- CRAC
- **Cooling_Tower**
- **Fans**
    - **Cooling_Tower_Fan**
    - **Exhaust_Fan**

  - **Outside_Fan**
  - **Relief_Fan**
  - **Return_Fan**
  - **Supply_Fan**
- **Heat_Exchanger**
- **Humidifier**
- **Pumps**
  - **Chilled_Water_Pump**
  - **Condenser_Water_Pump**
  - **Domestic_Water_Pump**
  - **Heating_Water_Pump**
- **Terminal Units**
  - FCU
  - **HP**
  - **Radiator**
  - **Unit_Heater**
  - VAV
- **Valves**
  - **Bypass_Valve**
  - **Condenser_Valve**
  - **Cooling_Valve**
  - **Heating_Valve**
  - **Isolation_Valve**

Point Tags

Each point shall use a tag to identify the point type or measurement type. This section describes the most common tags used, and the Bricks documentation should be referenced for tags not found in this list. These tags and usage information are listed in the Point Class in the Bricks documentation.

- **Alarm**
- **Command**
- **Parameter**
- **Sensor**
  - CO2
  - **CO**
  - **Contact_Sensor**
  - **Current_Sensor**
  - **Electrical_Power**
  - **Enthalpy**
  - **Fire_Sensor**
  - **Air-Flow**
  - **Gas_Flow**
  - **Water_Flow**
  - **Humidity**
  - **LEL_Level**
  - **Occupancy**
  - **Occupancy_Count**

  - **NOx**
  - **Refrigerant_Level**
  - **Thermal_Power**
  - **Differential_Pressure**
  - **Static_Pressure**
  - **Velocity_Pressure**
  - **Refrigerant_Level**
  - **Temp**
  - **Wetbulb_Temp**
- **Dewpoint_Temp**
- **Setpoint**
- **Status**

Ad Hoc Tagging

Some tagging will be implemented for labeling calculations and physical measurements related to energy and utility usage. These points may or may not be defined in the Bricks documentation but are listed here for use in tagging data in the system.

- **Electric_Power**
- **Gas_MBh**
- **Cooling_Demand**
- **Heating_Demand**
- **BTU**

Undefined Tags

When a point tag cannot be found in this document, or the Bricks documentation a proposed tag will be submitted to ASU for approval and inclusion in the tagging documentation. The name will follow the form of the tags listed here with descriptions capitalized and separated by an underscore. No spaces will be allowed.

Tagging Example:

For a Room Temperature sensor at B of A at Brickyard served by heat pump 1the tags would be associated as follows:

- Tempe_Campus
- Academic
  - B of A at Brickyard
    - 1st Floor
      - Office_103
        - Heat Pump 1
          - Room Temperature

The Room Temperature tag list would be as follows.

- MC
- Academic

- R10A
- 1st_Floor
- Office_103
- Zone_HP1
- HP1
- Air_System
- Room_Temperature_Sensor

Design and Coordination Considerations

Design Engineer

The design engineer will specify that all building systems including but not limited to Facility Management Systems, Energy Information Systems, Fire Alarm Systems, and Lighting Systems shall deploy points tagged using the BRICKS ontology. Specify that all tagging will use the BRICKS tagging guidelines, and the current ASU tagging dictionary.

Master System Integrators and Automation Contractors

Comply with all ASU naming conventions.

Engage ASU when a deviation to the naming system is encountered.

Provide a demonstration of proper naming and folder structures to the commissioning team and ASU prior to deployment.

Add any new names created for the project to the BRICKS tagging rules library.

Project Commissioning

Inspect the operating database during pre-installation demonstration and during commissioning to verify compliance with the naming, folder structure, and tagging standards.

Arizona State University

ASU should be prepared to assist the contracting team and commissioning team with any non-standard names encountered, and to witness the pre-installation demonstration as well as commissioning activities.

ASU will also maintain a base dictionary or Niagara station to provide the contractors at the beginning of the contract.

Section 9 – Folder Structure

Overview

This document will cover the standards for setting up the folder structure within the ASU BAS database. This structure should be followed at all 3 tier level controllers.

Folder Structure

It is important that the folder Structure within the database match the **BAS Naming Standard** found in

Chapter 7 of the **ASU Division 25 Guideline**, so the history names are correct and user searches are easily performed. The folder structure focus is on the Campus, the Site, the system type, and equipment type or zoning. Following this structure is especially important in the organizational enterprise database. If a building controller has two or more buildings, or areas reporting up to it, each one is to have its own folder structure in order to adhere to standards. Each component of the folder structure is described below:

1. Database – Campus Acronym_Facility Acronym_Controller Number
    a. Database Path / Specific Network (i.e., BACnet I.P. or MSTP Network)
        i. System Type: HVAC, Electrical, Lighting
            1. Sub System Type: Chilled or Hot Water System, AHUs, RTUs
                a. Equipment Type: AHU, RTU, Boiler, Chiller
                    i. Equipment Device
                        1. Points
                        2. Programming: All programming wire sheets that perform control logic will be in a folder named “Programming” under the device that hosts the program.

System names should be derived from **BAS Naming Standard** found in Chapter 7 of the **ASU Division 25 Guideline.**

Equipment names should never be the same within a single station, even when that equipment falls under a different folder path. For example, there should not be a VAV_01 on floor 1 and VAV_01 on floor 2. To avoid confliction with mechanical design, a VAV name is to start with VAV plus the number representing the AHU that is serving it. This is followed by an underscore, and then the mechanical design designation number or room number serving. For example VAV01_101.

Folder Naming Structure

This standard structure allows for a consistent look and feel, along with seamless integration with the Brick tagging and relations rules that are in place on the ASU system.

1. Database – Campus Acronym_Facility Acronym_Controller Number
    a. MC_R10A_01 – The first part will identify the campus, the second will be the facility that the controller is a part of, the third part will be a unique number identifier

signifying which number, out of the total supervisor controllers, this one is

2. System Type: HVAC, Electrical, Lighting
    a. These top level identifiers are for sorting data amongst the portfolios.
3. Sub System Type: Chilled or Hot Water System, AHUs, RTUs, etc
    a. This sub folder is where the common structure begins. Rules are based on looking for these folders and then traversing down.
    b. All sub folders and devices will be under one of the main system type folders defined in the naming standard.
4. Equipment Type:
    a. This level can either be a device or another folder for grouping devices, like in the case of VAV's.
    b. Reference the Standard point naming sheet for additional names
5. Equipment Device
    a. This is the device shadow object of the controller.
6. Points
    a. All standardly named I/O points reside here
    b. All software points reside here
    c. All trending and alarming starts here
    d. Reference the Standard point naming sheet for additional names – Standard point naming tab

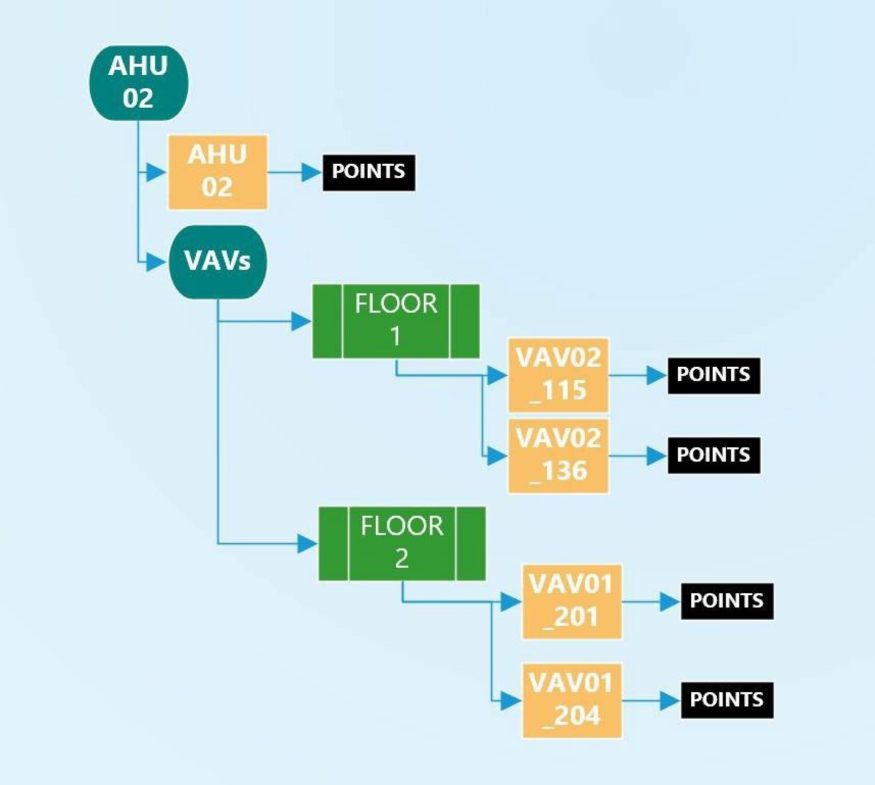
The previous criteria would result in a point name like: MC_R10A_01/Ahu01/DATmp

Outliers of existing equipment should be announced, and guidance should be requested via an RFI. Outliers of existing points should go in a folder called "MISC" and organized in a custom manner as clearly as possible.

Zoning

A "zone" folder shall be included in the folder structure when any system is serving multiple pieces of equipment, that need to be grouped together, in the space.

In the example below, Floor 1 and Floor 2 represent two different "Zones" served by AHU02.



Supervisor Relationship

The role of the supervisor station is to aggregate trend and alarm data from the building controllers, transport alarm data to external recipients for critical alarm notifications and serve up graphical representation of the systems.

The supervisor station shall not include any programming logic or calculated data intended to be utilized by the building controllers in any way. All global point passing shall be done at the building controller level.

The supervisor may include programming logic and calculated data for the purpose of aggregation in creating global reporting across multiple sites.

Section 10 – Graphics Requirements

Overview

This document will cover the standards for setting up graphic pages within the ASU BAS system.

General

ASU sites will deploy with a building controller that connect to the ASU BAS Server. The graphics and navigation for each building must be self-contained in the local building controller.

The development of graphics pages for ASU projects should be guided by the following general guidelines.

- The color scheme of the graphics pages should follow the ASU Color Palette.
- The look, feel and organization of the graphics pages should be the same as existing graphics pages.
- When developing equipment and flow diagram graphics use standard objects as much as possible.
- Ideas for new features, functions and appearance are welcome, but a prototype should be presented to ASU for approval before deployment.
- All graphics pages should be created on a Responsive pane to allow for pan & zoom features on a touchscreen or other mobile device.

Page Style

The standard screen size for design will be 1280 x 800 in a responsive pane for proper display on multiple device types and sizes.

The font will be the appropriate size for the application and use the same font as any existing ASU graphics. Any deviation from the default font will be Arial. Additional fonts may be used in limited application for specific aesthetic or usability reasons.

The colors for developing graphics have been chosen from the ASU web site and should be chosen from the following color palette if possible.

Hex Code	Color	Hex Code	Color
#FFF4D4	🟨	#701733	🟥
#FFF3CD	🟨	#691630	🟥
#F2E8C9	🟨	#541126	🟥
#ECE2C4	🟨	#440E22	🟥
#E6DCBF	🟨	#380C1A	🟥
#FFE8A9	🟨	#1C060D	🟥
#FFDD7D	🟨	#C2E1ED	🟦
#FFD152	🟨	#BDDBE6	🟦
#FFCF47	🟨	#B8D5E0	🟦

#FFCC3D	🟨	#99DAF3	🟦
#FFC627	🟨	#66C8EC	🟦
#DAA000	🟨	#33B5E6	🟦
#997717	🟫	#00BAFF	🟦
#7F6227	🟫	#00B0F3	🟦
#664F10	🟫	#00A3E0	🟦
#332808	⬛	#26B1E5	🟦
#BA778C	🟪	#1AACE3	🟦
#8C1D40	🟥	#006286	🟦
#771936	🟥	#00415A	🟦

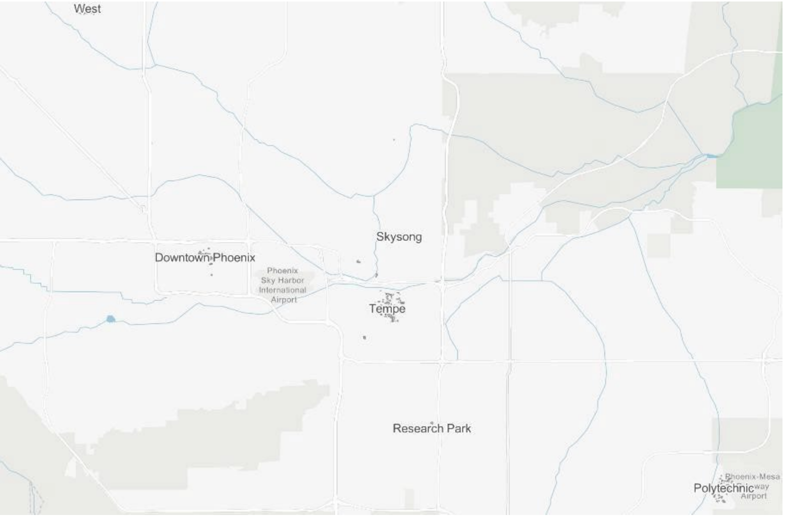
RGB Hex	RGB	Color
#CCCCCC	rgb(204,204,204)	⬜
#E0E0E0	rgb(224,224,224)	⬜
#EEEEEE	rgb(238,238,238)	⬜
#F6F6F6	rgb(246,246,246)	⬜
#FFFFFF	rgb(255,255,255)	⬜
#EBEBEB	rgb(235,235,235)	⬜
#F4F4F4	rgb(244,244,244)	⬜

Navigation

Navigation inside the controllers will be limited to 3 clicks from the home page to the information desired as much as possible. Navigations requiring more than 3 clicks should be only rare exceptions.

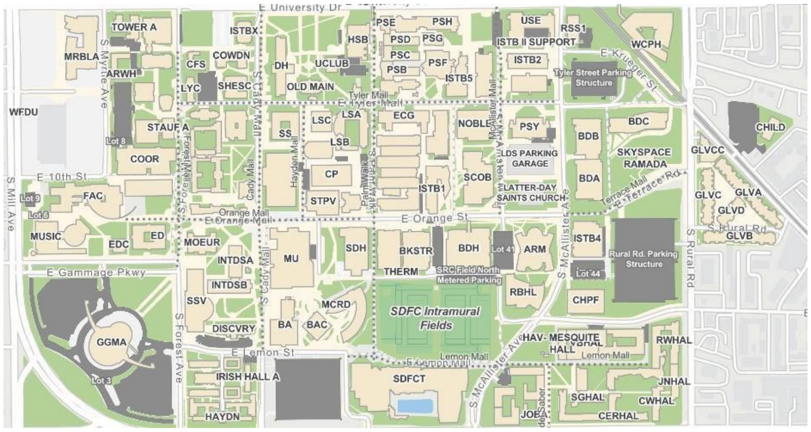
ASU navigation from the server will also be limited to 3 clicks to get to the local building controller or other information desired. Navigation inside the local site building controller will not be counted in the 3 clicks, but navigation inside that local site station should not require navigating back to a supervisor screen to make information quickly available in as few click as possible.

The server will contain a master home page with a map of the ASU campus. The map will include layers and provide hyperlinks for different regions as defined by ASU. Clicking on the region will navigate to a map showing the building in that region.



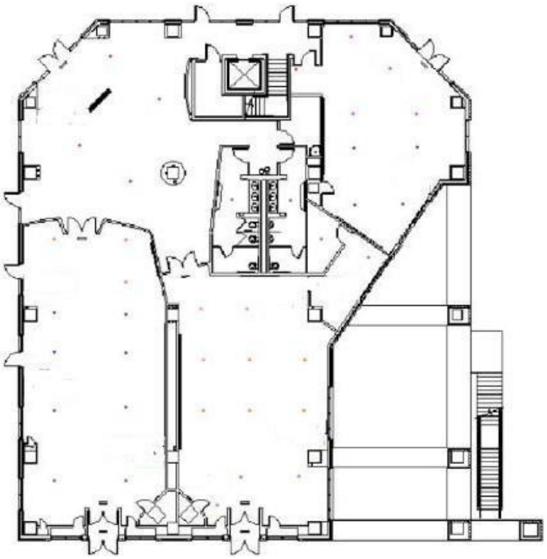
On the campus map, when a site is clicked it will display a new page with a site map for the building. If the site contains a single building, then the homepage for that building will display. The navigation menu bar should be visible and accessible from all graphic pages.

1. Average Zone Temp
2. Critical Alarms
3. Network Health
4. Energy



The home page for each site building controller will be a floor plan with multiple layers and navigation to each zone or piece of equipment.

1. Ventilation
2. Temperature
3. Lighting
4. EIS
5. Mechanical
6. Alarms
7. Labs



Display Point Functionality

Display points will display the appropriate linked value with units and be labeled with the point name. Display all points with one decimal place except the following:

Flow – display a whole number with no decimal places Room pressure – display with 3 decimal places

For setpoints, clicking on the point will allow either a permanent change or a timed override of the chosen setpoint. The background of an overridden value should match the ASU standard override color when an override is active.

For alarm points, alarms will display in red. Critical alarms will display in flashing red. All other functions of the point will follow BAS system default coloring.

Yellow – point is down, or device is not communicating. Orange – the point is in fault.

Red – alarm state as defined above Magenta – overridden.

Campus Views

The following information will be visible for each building on campus view pages through static value display, drop-down selection, or pop-up tool text.

Critical Alarms

Each building report critical alarms only

Network Health

Non-communicating devices, bad network metrics, diagnostics

Energy

BTU consumption and KWH.

In addition to the above, provide an energy dashboard as defined in “Energy Dashboards.”

Comfort Indicators

Provide the maximum, minimum and average space temperature. Provide the maximum, minimum and average space humidity.

Floor Plan Views

Floor plan graphics will contain the following information. Layers should be combined, or provided with separate graphic or drop-down selection, to create clear and legible graphics. Floor plan graphic prototypes will be presented to the ASU Facilities Team and the Commissioning Agent prior to implementation.

Temperature Floor Plan View

Floor plans will display the zone temperature as a value and the zone will have a gradient displaying distance from room setpoint with Blue being too cold, red being too hot and transparent being within 3°F of setpoint. For clean rooms the zone will be transparent within 1°F of setpoint.

Clicking on the zone will hyperlink to the equipment serving the zone.

Ventilation Floor Plan View

Location of variable air volume boxes and thermostat, Exhaust fan

Mechanical Floor Plan View

Location of mechanical room AHU or related equipment and link to sequence of operation.

Alarms Floor Plan View

Critical alarms and priority value

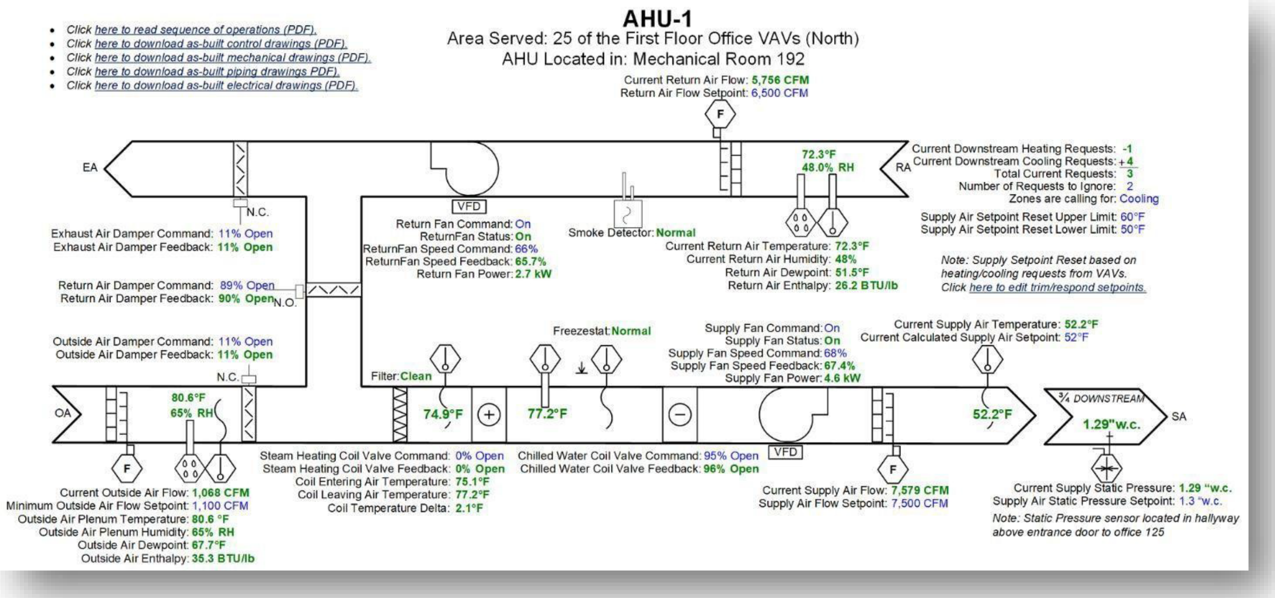
Labs Floor Plan View

Clean/Labs rooms will have their own detail Floor Plan View and will be identical to the floor plans displayed on the clean room touch screen displays.

Air Handling Unit Views

Air handling unit views will contain at minimum the following relevant points. All data points used in the operation of the air unit will be available to the operator within 3-clicks of the main air handling unit view. All functionality described above, and in the General Graphics Requirements will apply to the points and information displayed on the air handling unit views.

Point	Point Name	Alarm	Archive
Supply Air Temperature	SATmp	X	X
Supply Air Static Pressure	SAStPrs	X	
Supply Air Static Pressure High Limit	SAStPrsHL	X	
Mixed Air Temperature	MATmp		
Return Air Temperature	RATmp		
Return Air Humidity	RARelHum		
Outside Air Damper Command	OADmpCmd		
Return Air Damper Command	RADmpCmd		
Mixed Air Damper Command	MADmpCmd		
Supply Air Fan Command	SAFanCmd		
Supply Air Fan Status	SAFanSts	X	
Return Air Fan Command	RAFanCmd		
Return Air Fan Status	RAFanSts	X	
Cooling Valve Percent Open	ClgVlvCmd		X
Heating Valve Percent Open	HtgVlvCmd		X
Occupancy	Occ		
Supply Air Duct Static	SAStPrs		
Return Carbon Dioxide	RACO2	X	X
Btu Cooling	ClgEnrg		X
Btu Heating	HtgEnrg		X
Air Changes	AirChg		X



- Click here to read sequence of operations (PDF).
- Click here to download as-built control drawings (PDF).
- Click here to download as-built mechanical drawings (PDF).
- Click here to download as-built piping drawings PDF).
- Click here to download as-built electrical drawings (PDF).

AHU-1
Area Served: 25 of the First Floor Office VAVs (North)
AHU Located in: Mechanical Room 192

Current Return Air Flow: 5,756 CFM
Return Air Flow Setpoint: 6,500 CFM

Current Downstream Heating Requests: -1
Current Downstream Cooling Requests: +4
Total Current Requests: 3
Number of Requests to Ignore: 2
Zones are calling for: Cooling

Supply Air Setpoint Reset Upper Limit: 60°F
Supply Air Setpoint Reset Lower Limit: 50°F

Note: Supply Setpoint Reset based on heating/cooling requests from VAVs.
Click here to edit trim/respond setpoints.

Exhaust Air Damper Command: 11% Open
Exhaust Air Damper Feedback: 11% Open

Return Air Damper Command: 89% Open
Return Air Damper Feedback: 90% Open

Outside Air Damper Command: 11% Open
Outside Air Damper Feedback: 11% Open

Return Fan Command: On
ReturnFan Status: On
ReturnFan Speed Command: 66%
ReturnFan Speed Feedback: 65.7%
Return Fan Power: 2.7 kW

Smoke Detector: Normal

Current Return Air Temperature: 72.3°F
Current Return Air Humidity: 48%
Return Air Dewpoint: 51.5°F
Return Air Enthalpy: 26.2 BTU/lb

Freezestat: Normal

Filter: Clean

Supply Fan Command: On
Supply Fan Status: On
Supply Fan Speed Command: 68%
Supply Fan Speed Feedback: 67.4%
Supply Fan Power: 4.6 kW

Current Supply Air Temperature: 52.2°F
Current Calculated Supply Air Setpoint: 52°F

Steam Heating Coil Valve Command: 0% Open
Steam Heating Coil Valve Feedback: 0% Open
Coil Entering Air Temperature: 75.1°F
Coil Leaving Air Temperature: 77.2°F
Coil Temperature Delta: 2.1°F

Chilled Water Coil Valve Command: 95% Open
Chilled Water Coil Valve Feedback: 96% Open

Current Outside Air Flow: 1,068 CFM
Minimum Outside Air Flow Setpoint: 1,100 CFM
Outside Air Plenum Temperature: 80.6 °F
Outside Air Plenum Humidity: 65% RH
Outside Air Dewpoint: 67.7°F
Outside Air Enthalpy: 35.3 BTU/lb

Current Supply Air Flow: 7,579 CFM
Supply Air Flow Setpoint: 7,500 CFM

Current Supply Static Pressure: 1.29 "w.c.
Supply Air Static Pressure Setpoint: 1.3 "w.c.

Note: Static Pressure sensor located in hallway above entrance door to office 125

Variable Air Volume Terminal Views

Variable Air Volume (VAV) terminal views will contain at minimum the following relevant points. All data points used in the operation of the air unit will be available to the operator within 3-clicks of the main air handling unit view. All functionality described above, and in the General Graphics Requirements will apply to the points and information displayed on the VAV terminal views.

Point	Point Name	Alarm	Archive
Room Temperature	RmTmp	X	X
Discharge Air Temperature	DATmp	X	
Air Flow	AirFlw		
Room Temperature Setpoint	RmTmpSp		
Cooling Command Percent	ClgCmd		X
Heating Command Percent	HtgCmd		X
Occupancy	Occ		
Supply Air Temperature from AHU	AhuSATmp		
Duct Static from AHU	AhuSAStPrs		

CO2	RmCO2	X	X
BTU Cooling	ClgEnrg		X
BTU Heating	HtgEnrg		X
Air Changes	AirChg		X
Damper position	DmpCmd	X	X

Plant Views

Plant views will be customized to depict the plant in a clear manner as determined by the plant size and project requirements. The plant view should reflect all points involved in the plant through various views. At least one overview graphic should be provided showing all piping, animated equipment, and the necessary data to determine proper plant operation. Additional views as necessary may be developed so that all plant operation data is available to the operator within 3 clicks of the main plant screen.

Energy Graphics

Provide a dashboard for each building showing the following data:

- Building Total Energy Consumption
    - kWh (kilowatt-hours): Total energy consumed by the building over a specific period.
    - BTU (British Thermal Units): Measurement of energy usage for heating and cooling.

- Building Peak Demand
    - kW (kilowatts): The highest level of power demand observed during a specific period, typically monitored monthly.

- Energy Consumption and Demand by End-Use
    - HVAC Systems: kWh or BTU / kW / Cooling Tons used for heating, ventilation, and air conditioning.
    - Lighting: kWh / kW consumed by lighting systems.
    - Plug Loads: kWh / kW used by all plug-in equipment and appliances.
    - Process Loads: Energy used by industrial processes or other specific activities.

- Renewable Energy Production (if applicable)
    - kWh Generated: Amount of energy produced by on-site renewable sources such as solar panels or wind turbines.
    - Renewable Percentage of Total Energy: The proportion of total building energy supplied by renewable sources.

- Load Factor (if available)
    - Load Factor (%): Avg Load / Peak load - Ratio of average energy usage to peak energy usage over a period, indicating how effectively the energy is used.

- Water Usage

  - Gallons Used: Total water consumption, critical for buildings with significant water heating or cooling processes.
  - Water Use Intensity (WUI): Gallons of water used per square foot of building space per year.

Miscellaneous Views

Miscellaneous views will be developed as project conditions require based on the look, feel and function of the other pages in the station.

General Graphics Requirements

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. 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.

D. 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.

E. 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 configuredgeometry.
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 representdials.
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.

F. Symbol library – The BAS 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 BAS 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. 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.

G. Graphical displays shall include room, zone, and sensor/thermostat locations.

H. The graphics should clearly reflect the sequence of operations. (links to SOO must be included).

I. A controlling variable should always be placed adjacent to its set-point. (What is the current status vs what is supposed to be).

J. On screen point names should be verbose/descriptive and make sense based on the sequence of operations.

K. Include system and/or unit schematics wherever possible and minimize generic graphics images that don’t accurately reflect the system depicted.

L. Animations should always be based on feedback- not on command.

M. Navigation should be based on system relationships and space served.

N. Graphics shall be linked to preconfigure trend charts to show controlled values and compare it to actual setpoint and controlled output for at least 24hrs. For example, a trend chart for supply duct static pressure, supply duct static pressure setpoint, and supply fan speed, and another chart for supply temperature, setpoint, heating, cooling, and economizer signals.

Design and Coordination Considerations

Design Engineer

The design engineer will specify that all items necessary for the project documents to comply with this guideline and coordinate additional requirements with the ASU Facilities Team.

Master System Integrators and Automation Contractors

Use this guide and the project documentation to develop a fully functional graphical user interface for the project and demonstrate the graphics to ASU and the Commissioning Agent prior to installation.

Project Commissioning

Inspect the operating database graphics during pre-installation demonstration and during commissioning to verify compliance with the naming standards.

Perform all functional testing procedures possible through graphical user interface to verify a properly functioning graphic.

Arizona State University

ASU should be prepared to witness the pre-installation demonstration as well as commissioning activities.

Section 11 – Alarming Requirements

Overview

The intent of this document is to provide a definition of ASU Alarm Classes and routing. In addition to these requirements specify compliance with alarming and fault detection requirements defined in the latest version of ASHRAE Guideline 36.

Definitions

Enterprise Console	The alarm console of the Enterprise Server for the system. Local
Console	The alarm console of the Enterprise Building Controller.
General Alarm	An alarm of a piece of non-critical equipment or related to the space comfort of the non-critical room support zones.

Critical Alarms	Alarms relating to any critical operations or system transitions.

Alarm Class

General Alarm

A General Alarm shall occur when any piece of non-production equipment or the comfort of the space is outside of limits for more than 1 hour.

A General Alarm will be routed to the local alarm console.

Critical Alarms

A Critical Alarm will occur when any piece of equipment has a state mismatch or critical value out of range for more than 5 minutes, if any monitored pressure is outside of limits for more than 2 minutes, or if any space temperature or humidity is outside of limits for more than 20 minutes. Times may need to vary to match the application.

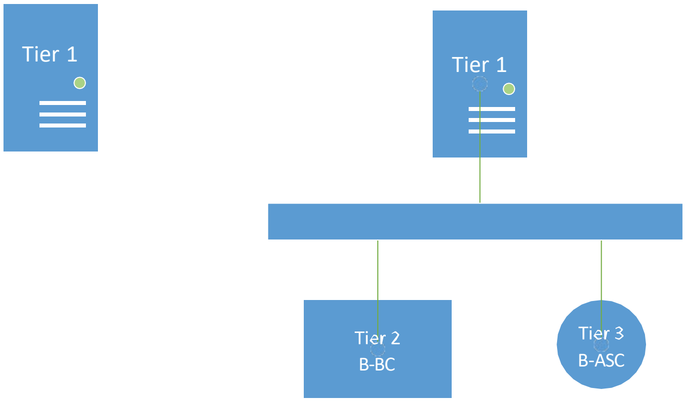
A Critical Alarm will be routed to the local console and communicated by email and/or text to the appropriate ASU personnel.

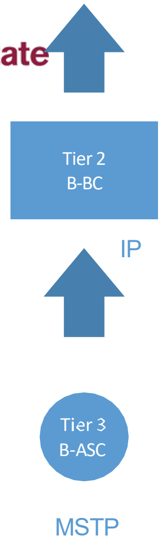
Alarm Configuration

Alarm Object

Alarms creation will remain as close as possible to the source object. The purpose of creating alarms at the source controller is to maintain autonomy and lower network bandwidth on the network.

- BACnet objects will require configuration of intrinsic reporting.
    - Fault
    - Overridden
    - Out of Service
    - In Alarm
- If the object does not support Intrinsic reporting the alarm object will reside in the same database as the monitored value.
- Notification classes distribution list will be configured to report alarms in an ascending manner. If the tier3 controller is an IP device it may distribute alarms directly to a tier1 device.





Alarm Types

Change of value alarms scenarios

- Should be implemented when the monitored object resides in the same device as the alarm object.
- If the Alarm must reside at a different tier in the network, and the BACnet object does not support COV or cannot handle more active COV subscriptions then the alarm object should be configured with a polling interval to minimize network bandwidth usage.

Proprietary alarms

- Polling interval will be configured in coordination with ASU staff.

Alarm Consoles

Enterprise Console

The Enterprise Console is the alarm console of the enterprise server. All alarms in the system route here, and the console is viewable by hyperlink to Administrator level users.

Local Console

The Local Console is the alarm console of the building controller or site level server if it exists. All alarms in the local building are routed here. If more than one building controller is present, one controller will be designated the Building Server, and all building alarms will be routed to appear in the local alarm console of the building server. This console will be hyperlinked to the building graphics, and visible to the appropriate site personnel and ASU Administrator users.

Alarm Consoles will be configurable so that users can sort and filter alarms for their desired task.

Critical Alarm Reporting

All Critical Room and Hazardous alarms will be routed using email and/or text message as determined by each site. These alarms will be routed using the ASU alarm email account (bas_alarms@ASU.com). Password for this account is maintained by the ASU BAS Team.

If these alarms are not acknowledged within 30 minutes the alarm will route again and include additional personnel. This shall repeat every 30 minutes until the alarm has been acknowledged.

These classes of alarms will contain a notes property to be used by the site teams to include procedures and troubleshooting checklists for responding to the alarm.

The alarm reporting should be configured to easily route to the facility team member who is currently on-call by time schedule. Time schedules will be editable from a graphic page associated with the building that the alarm originates.

Critical Alarm Limits

Equipment status alarms shall latch until acknowledged by an operator.

Miscellaneous Alarms

ASU may at their discretion change the routing and feature of any individual alarm as required to meet the needs of the individual site.

Alarm Priority Assignment

Alarm priority ranges shall be implemented within, and in addition to, individual alarm classes. Contractor shall coordinate with ASU to obtain the latest alarm priority and class definitions.

Alarm priority ranges shall be incorporated into the alarm setup to facilitate sorting within alarm classes in the alarm console and alarm reporting.

Alarm Suppression

If the main system is in alarm, second level alarms will be suppressed by the system alarm. For example, if AHU-1 fails all VAVs under AHU-1 shall be inhibited by AHU-1 until it returns from failure.

Alarm Operator Interface

1. All alarms shall include a time/date stamp.
2. Each alarm can be configured as follows:
    a. Requires acknowledgement.
    b. Does not require acknowledgement.
    c. Time delay
    d. Post suppression period.
3. Sorting of alarms based on level, time/date, and status and include.
    a. Date and time of the alarm.

b. Alarm Class of the alarm
c. Alarm Priority of the alarm
d. Description of the alarm
e. Equipment tags for the units in alarm
f. Probable causes of the alarm if provided by the fault detection routines.

Alarm Notes For Record Drawings

The following notes should be on the project BAS drawings from the engineer of record:

1. This section gives requirements for handling any point in the bas which is currently in alarm. When the sequence of operation instructs to generate an alarm, the point shall become in alarm. After a return to normal state or value, and following a similar time delay or appropriate deadband, the point shall no longer be in alarm.
2. All alarm parameters, including but not limited to alarm limit values, alarm time delays, and alarm change of state thresholds, shall be adjustable via interface as properties on the corresponding point or as discrete points.
3. Clearly indicate points with alarm flags, alarm parameters, and discrete alarm points, in the points lists provided to the integrated automation provider.
4. Configure default text associated with discrete alarm and parameter points to clearly describe each value. Adjust text describing binary states from “true / false” to appropriate state text, such as “alarm / normal.” Apply text in a consistent manner across all similar system points.

Design and Coordination Considerations

Design Engineer

The design engineer will specify that the BAS should alarm all critical values from the system designed and comply with the alarming and fault detection definitions in the current version of ASHRAE Guideline 36.

Master System Integrators and Automation Contractors

Comply with all alarming considerations in the project and coordinate any suggested additional alarms with the owner.

Eliminate nuisance alarms prior to project commissioning.

Project Commissioning

Verify that alarms are working as intended, that all fault detection as described in the current version of ASHRAE Guideline 36 are present, and that nuisance alarms have been eliminated prior to acceptance by the owner.

Section 12 – Trending Requirements

Overview

The intent of this document is to provide a basis for the configuration of trends that serve the purposes of both facility maintenance staff, and energy and sustainability staff. These guidelines are the minimum standard for trending, and should be supplemented to serve the needs of each project.

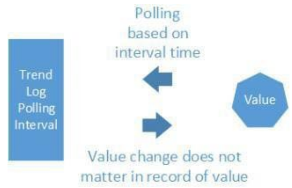
BACnet Trend Log Object

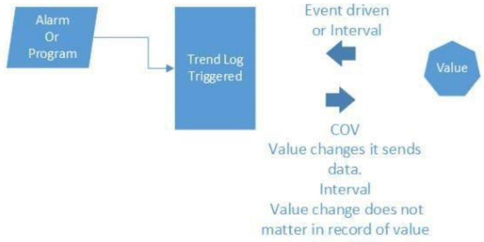
Trend Log object definition

A Trend Log object monitors a property of a referenced object and, when predefined conditions are met, saves ("logs") the value of the property and a timestamp in an internal buffer for subsequent retrieval.

The data may be logged with the following options:

1. Periodically
   a. Polling interval
2. Upon a change of value
   a. Change of value subscription
3. Triggered
   a. by a write to the Trigger property





Creation of the object will remain as close as possible to the source object. The purpose of creating the trend object at the source controller is to maintain autonomy and lower network bandwidth.

If the Trend Log object must reside at a different tier in the network, and the BACnet object does not support COV or cannot manage more active COV subscriptions then the Trend Log object should be configured as an interval log to minimize network bandwidth usage.

Change of Value increment parameter in the BACnet server device must be configured in coordination with ASU to prevent excessive records that may not meet the required ASU standards.

Point	COV Increment
Space Temperature	0.5°F
Outside Air Temperature	1°F
System Temperatures	0.5°F
Space/Duct Relative Humidity	1%
Outside Relative Humidity	2%
Carbon Dioxide	5 PPM
Duct Static Pressure	0.005 in WC
Room/Building Static Pressure	0.005 in WC
Laboratory Static Pressure	0.002 in WC
Water Differential Pressure	0.05 PSI
System Pressure	1 PSI
Air Flow	2 CFM
Fluid Flow	1 GPM
BTU Meters	1 BTU

Coordinate other values with ASU Facilities.

The Notification Class distribution list will be configured to report logs in an ascending manner. If the tier3 controller is an IP device it may distribute logs directly to a tier1 device.

Proprietary Trend Configuration

Proprietary trend objects are referred to as objects that are native to the automation controller but do not adhere to any open protocol specifications. Proprietary objects may or may not include all options supported by the BACnet Trend Log Object. Deployment of proprietary may require further understanding to make sure they do not have a negative impact on the network.

All binary trends will be change of state (COS) trends. If the trend object does not reside within the same controller as the monitored binary object. The poll interval must be configured to prevent continuous polling or intervals below 5 seconds of polling.

All analog trends will be sampled at 15-minute intervals.

Trend Storage

Trends shall be stored in the local building controller for a period of two weeks. Then data shall be removed on a first in first out (FIFO) basis. T**rend Displays**

- A summary chart for each piece of equipment containing all the trended values for that piece of equipment.

- A summary chart with all equipment run status trends and building pressure (if available).
- A Summary chart with all trended inputs, outputs, and intermediary control values for each distinguishable section of the sequence of operation to aid in troubleshooting sequence of operation problems.
- A summary chart with all space temperatures.
- Energy data will be displayed in a real timeline plot, and in a historical histogram showing daily, weekly, and monthly use. A comparison histogram showing the current period energy use to the last week, last month and last year should be available for viewing.

Trend Configuration

All binary trends will be change of state trends.

Equipment analog trends will be sampled at 15-minute intervals. These include but are not limited to the following:

1. All physical point values for controlled equipment
2. All equipment intermediate control values that provide troubleshooting information for the individual equipment
3. Equipment cooling status.
4. Equipment heating status.
5. Fan unit run status.
6. Zone heat Status
7. Zone discharge air temperature
8. Air flow for each individual flow sensor
9. Total air flow for each space

Trend Storage

Equipment trends shall be stored in the local building controller for a period of one month. Then data shall be removed on a first in first out (FIFO) basis. These include but are not limited to the following:

1. All physical point values for controlled equipment
2. All equipment intermediate control values that provide troubleshooting information for the individual equipment
3. Equipment cooling status.
4. Equipment heating status
5. Fan filter unit run status.
6. Zone heat Status
7. Zone discharge air temperature
8. Air flow for each individual flow sensor
9. Total air flow for each space

Zone Trends

Zone trends shall be stored in the local building controller for a period of one month, archived daily and stored on the enterprise server for 7 years. Then data shall be removed on a first in first out (FIFO) basis. These include but are not limited to the following:

1. Space temperature
2. Space humidity
3. Space pressure

Trend Displays

1. A summary chart for each piece of equipment containing all the trended values for that piece of equipment.
2. A summary chart for the air unit cooling control.
3. A summary chart for the air unit humidity control.
4. A summary chart for the zone temperature control.
5. A summary chart for each zone showing all values associated with that zone.
6. A summary chart showing temperature, humidity, and air changes for all zones.
7. A summary chart showing the space pressures for all zones.
8. Preconfigure trend charts to show CV and compare it to actual setpoint for at least 24 hours.

Trends for Typical Systems

The following are lists of trends for typical systems. This list is the minimum required, and not exhaustive. It should act as a guide for setting up trends for systems not listed.

Air Handling Units (AHUs)

1. Supply Air Temperature
2. Return Air Temperature
3. Mixed Air Temperature
4. Discharge Air Temperature
5. Supply Air Pressure
6. Return Air Pressure
7. Mixed Air Dampers Position
8. Outside Air Dampers Position
9. Return Air Dampers Position
10. Filter Differential Pressure
11. Cooling Coil Valve Position
12. Heating Coil Valve Position
13. Humidifier Status

14. Fan Status (On/Off)
15. Fan Speed (VFD Output)
16. Static Pressure Setpoint
17. Static Pressure Actual
18. Energy Consumption (kWh)
19. Current Draw (Amps)
20. Fault Alarms (e.g., high static pressure, high/low temperature)
21. Relative Humidity

Pumps

1. Pump Status (On/Off)
2. Pump Speed (VFD Output)
3. Flow Rate
4. Suction Pressure
5. Discharge Pressure
6. Differential Pressure
7. Energy Consumption (kWh)
8. Current Draw (Amps)
9. Fault Alarms (e.g., no flow, high/low pressure)
10. Pump Runtime

Fans

1. Fan Status (On/Off)
2. Fan Speed (VFD Output)
3. Supply Air Flow Rate
4. Return Air Flow Rate
5. Static Pressure
6. Energy Consumption (kWh)
7. Current Draw (Amps)
8. Filter Differential Pressure
9. Fault Alarms (e.g., high static pressure, motor overheating)
10. Fan Runtime

Variable Air Volume (VAV) Boxes

1. Zone Temperature
2. Supply Air Temperature
3. Damper Position
4. Airflow Setpoint
5. Actual Airflow
6. Reheat Coil Valve Position
7. Fan Status (if equipped)
8. Static Pressure
9. Zone Occupancy Status
10. Fault Alarms (e.g., damper malfunction, temperature setpoint deviation)

Active Chilled Beams

1. Primary Air Supply Temperature
2. Primary Air Flow Rate
3. Primary Air Pressure
4. Induction Ratio
5. Zone Temperature
6. Zone Humidity
7. Occupancy Status

Passive Chilled Beams

1. Radiant Panel Surface Temperature
2. Room Air Temperature
3. Room Humidity
4. Supply Air Temperature (if applicable)
5. Supply Air Flow Rate (if applicable)

Design and Coordination Considerations

Design Engineer

The design engineer will specify that the BAS should trend all values in compliance with the owners guidelines and direction.

Master System Integrators and Automation Contractors

Comply with all trending considerations in the project and coordinate any suggested additional trends with the owner.
Trend charts should be pre-configured before completion of the project.
Verify that the storage and delivery of the trends do not have adverse effects on the campus BAS server.

Project Commissioning

Verify that trends are working as intended, and that useful trend charts are pre-configured for the use of ASU.

Arizona State University

Coordinate with BAS contractor and design team to verify that all trends required to operate the building and provide information for information and sustainability are configured.

DIVISION 26 - ELECTRICAL

26 00 02 - General Information for Electrical Systems

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.

Code and Ordinances:

A. All materials and workmanship shall comply with all applicable Codes, Specifications, Local, State Ordinances, Industry Standards and provisions found in this document.

   1. Applicable Codes and Standards shall include all State Laws, Local Ordinances and the current and applicable requirements of the following accepted Codes and Standards. Conform to, although not limited to, the following:

      a. International Building Code (IBC).

      b. National Electrical Code (NEC).

      c. International Fire Code (IFC).

      d. National Fire Protection Association (NFPA).

      e. International Energy Conservation Code (IECC).

      f. International Electrical Testing Association (NETA).

      g. Underwriter’s Laboratories (UL).

      h. Institute of Electrical and Electronics Engineers (IEEE).

      i. National Electrical Manufacturers Association (NEMA).

      j. National Electrical Contractors Association (NECA).

   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 Facilities Management (FM) electrical engineer.

Electrical System Overview - ASU Tempe Campus:

A. The Utility Company specifies the location of the service point. At the ASU Tempe Campus, this service point is in four locations:

   1. The Central Plant substation, located just north of the ASU Central Plant.

   2. The west substation, located by Parking Structure #3.

   3. The northeast corner of University Drive and Veterans Way, parking lot #57.

   4. The Combined Heat and Power Plant (CHP), southwest of Parking Structure #4.

B. 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 bus. The service point is the point on the wiring system where the serving utility ends and where the premises' wiring begins.

C. 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-phase, 3-wire, DELTA connected primary with a, 3-phase, 4-wire WYE secondary. The primary distribution conductors feed into distribution transformers designed to step down the primary voltage into secondary voltages based on building and load requirements.

D. For new design, voltage for receptacles, equipment, 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. Lighting shall be designed at 277V from 480Y/277V transformer secondary distribution. Transformers may also be 120/208V - 3 phase - 4 wire "WYE" for entire building requirements. This decision shall be made by the Design Engineer and approved by ASU Capital Program Management Group/Facilities Management Electrical Engineer and Electrical Services and will be influenced by the relationship between the motor lighting load and the total load within the building.

E. 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 (Medium Voltage Cables).

<u>Emergency Power Overview - ASU Tempe Campus:</u>

A. Emergency power for life safety emergency loads is supplied from the following locations:

1. The ASU Central Plant.
2. The Combined Heat and Power Plant (CHP) facility, southwest of Parking Structure #4.
3. Independent emergency generators throughout the site.

B. 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 volts – 600 volts or 4,160 volts - 480 volts four transformers located throughout the 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.

C. Emergency power from the CHP is distributed via an underground conduit system. Emergency power from the CHP is distributed at 4,160 volts to selected 4,160 -480Y/277V 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.

D. Standby or legally required systems shall not be connected to any emergency power systems. These loads shall be powered from a separate system within the project and its budget.

E. ASU at the Tempe campus has in place a 600/480 V emergency power system throughout the tunnel system which is in the process of being upgraded to a 4,160 volt distribution system and has selectively located 600-volt distribution panels.

F. New buildings must be designed to feed emergency power from the 4,160 volt emergency power generator system installed in Central Plant with the use of 4160 480Y/277V 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.

G. 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 (https://www.asu.edu/fm/documents/project_guidelines/Electrical-Reliability.pdf.

26 00 02 - General Design Requirements / Recommendations for Electrical Systems

Equipment and Material:

A. Equipment, and materials, shall be new, unused, without blemish or defect and manufactured not more than twelve (12) months prior to installation.

B. Equipment, fixtures and materials shall be UL listed and labeled, or certified by a nationally-recognized, independent testing laboratory acceptable to the ASU Facilities Management (FM) Electrical Engineer.

C. 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.

D. All drawing symbols must be shown on the drawings in a section describing the symbols and giving specifications of the item.

E. For the purpose of DIVISION 26, ELECTRICAL, the term "approved equal" will be the determination of the ASU Electrical Services Supervisor and the CPMG Director, who will have the final decision.

F. ASC Ratings depending upon feeders (as approved by Campus Engineer) to meet calculation (for full calculated loads).

General Requirements:

A. For new installations and TIs, a maximum of 4 receptacles will be allowed on each 20 A (amp) circuit, with a dedicated circuit for all appliances such as; copiers, network printers, microwave and refrigerator circuits.

B. A maximum of three (3) circuits is recommended per approval of AHJ in each conduit for all new installations.

C. Main feeders, or branch circuit conductors shall not be brought into the back of a power panel or switchboard, unless previously approved by the Facilities Management (FM) Electrical Engineer.

D. 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.

E. Power supply and identification shall be provided for electric door locks. Control location for monitoring shall be as approved by ASU Lock Shop.

F. 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.

G. All drawing symbols must be shown on the drawings in a section describing the symbols and giving specifications of the item.

H. 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.

Installations in Mechanical Rooms and Equipment Locations

A. Provide adequate safe access and manufacturer’s recommended working clearances for all equipment.

B. 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.

C. Provide direct access from the exterior for main building electrical rooms exceeding 100 net square feet.

D. In phased projects, electrical rooms shall be sized to include equipment for all the phases.

E. Electrical rooms shall have a floor drain.

26 05 00 - Common Work Results for Electrical

Wiring connections to equipment included in other sections.

Package Equipment:

A. 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 electrical connections to the components.

B. 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.

C. Motor disconnect switches, circuit breakers, and variable frequency drives for package equipment will be furnished, installed, and connected by the electrical contractor where required.

D. 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.

E. 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.

Elevators:

A. Electrical wiring of elevators and/or cranes will be done by an Arizona state-licensed elevator contractor.

B. The electrical contractor shall provide a convenience outlet and light in the elevator pit, elevator machine room, and car top and where emergency power is available. Each shall be connected to the emergency power panel. Elevator raceways will be installed per this Division.

C. The safety switch for the elevator equipment shall contain normally-closed and normally-open dry auxiliary contacts that operate with the blades of the safety switch.

D. The electrical contractor shall 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. All elevator smoke or heat detection devices shall report to the building fire alarm panel.

Special Systems:

B. Conduit and wiring shall be installed as required by this division, for metering, program clock systems, emergency power, and central controls system. Telephone, TV antenna and data systems shall be installed per ASU Telecommunications Guidelines. Fire alarm systems shall be installed per ASU Fire Alarm Guidelines (Section 28 30 00).

26 05 05 - Electrical Demolition

A. Power shutdowns required to perform demolition shall be coordinated with ASU Capital Programs Management Group (CPMG) and Electrical Services Supervisor.

B. All conduit and conductors that are removed under demolition work shall not be reused.

C. At the completion of a project, turn over to ASU all removed electrical devices.

D. 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 panel board.

E. 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(s) to operating condition.

F. 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.

G. Any metering devices, current transformers (CT) or potential transformers (PT) removed as part of the demolition shall be returned to the ASU Energy Information System (EIS) Supervisor. Care shall be taken to make sure these devices are not damaged during their removal.

26 05 13 - Medium Voltage Cables:

Description: Medium voltage cable and accessories for systems rated above 600V to 15,000V.

Cable:

A. Medium Voltage Cables shall be new, 5kV and 15kV single copper compact stranded conductor Ethylene Propylene Rubber (EPR) shielded power cable rated at 5kV and 15kV, 133% level type MV-105, 3-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. Minimum size for 5kV conductors shall be #2 AWG. Maximum size for 15kV conductors shall be 750 MCM.

MEDIUM VOLTAGE CABLE SPECIFICATIONS

A. Scope:

1. This specification covers single conductor-shielded power cable insulated with an ozone and discharge-resistant, flexible, rubber-like thermosetting dielectric.
2. 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.

B. Standards:

1. All cable shall conform to the current standards:
    a. Insulated Cable Engineers Associated (ICEA) S-93-639/ S-97-682
    b. American Society for Testing and Materials (ASTM).
    c. Association of Edison Illuminating Companies (AEIC) CS-8, latest edition.
    d. UL 1072.

C. Basic Construction:

1. 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,

2 x .005" shielding tape or #20 drain wires, separator tape and overall jacket.

D. ***Conductor:***

1. Conductor shall be uncoated copper compact stranded per ASTM B-496.

E. ***Conductor Shield:***

1. 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 percent and the brittleness temperature not warmer than 40 degree C.

F. ***Insulation:***

1. The insulation shall be Ethylene Propylene Rubber (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.

G. ***Insulation Shield:***

1. 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.

H. ***Metallic Shield***

1. Provide one of the following:
   a. 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 placed on the outside of the copper tape to double the phase to ground fault capacity of the 5 mil copper tape.
   b. Two, 5 mil copper tapes (2 x 5 mil) helically wrapped with an opposite lay and 12.5% nominal overlap.

I. ***Jacket:***

1. The overall jacket shall be thermoplastic black PVC for conduit or direct burial.

J. ***Corona:***

1. 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-8-13. Manufacturer is required to submit the X-Y recording graph showing flat line corona test results.

K. ***Quality Assurance:***

1. 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.

2. Each reel of completed power cable shall be newly manufactured (no more than 12 months old) and shall bear a tag containing the name of manufacturer, NEC designation, year of manufacture and all information noted in this section.
3. Cable manufacturer shall be Okonite Okoguard®-Okoseal® MV-105, or equal as approved by Electrical Services Supervisor.

Splices and terminations:

A. All splices and terminations shall be performed by qualified cable splicers who have had at least eight (8) years of experience in the “Cable Splicer” classification and at least five (5) years of experience with this type of cable. The qualifications of cable splicers shall be submitted for approval to the ASU Electrical Services department.

B. 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.

C. 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.

Warranty:

A. Manufacturer shall offer a 40-year warranty against dielectric breakdown due to materials or workmanship. The warranty 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 manufacturer, the manufacturer shall agree to repair or 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 manufacturer’s procedures.

26 05 19 - Low-Voltage Electrical Power Conductors and Cables (600V and Less)

Description: Building wire and cable with insulation rated 600V and less.

A. Insulated wire conductors for circuit voltage 600V or less shall be stranded or solid 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 for cable larger than #4/0 AWG size and in wet locations. All conductor sizes shall be fully rated for the entire length of the feeder run. Conductors oversized 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.

B. All raceways shall be supplied with the proper NEC-sized, green or bare copper, grounding conductor.

C. All wire and cable shall be color coded as follows:

120/208 Volt	480/277 Volt
A-PHASE – BLACK	A-PHASE - BROWN
B-PHASE – RED	B-PHASE - ORANGE
C-PHASE – BLUE	C-PHASE - YELLOW
NEUTRAL – WHITE	NEUTRAL - GRAY
GROUND - BARE OR GREEN	GROUND - BARE or GREEN

D. 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.

E. When a 20 A single-pole circuit for power and lighting exceeds 100’ for 120 V circuits or 150’ for 277 V circuits from device to panelboard, use #10 AWG wire or larger as required to achieve a maximum 3% voltage drop at full circuit capacity.

F. For all non-linear loads, install a separate identified neutral conductor for each phase conductor. Conductors for non-linear loads shall be a minimum size of #10 AWG for 20 A circuits. Exception will be made for single-phase, non-linear lighting circuits.

G. All wire and cable shall be stranded or solid copper to maximum size #12 AWG. Conductor sizes #10 AWG and larger shall be stranded copper.

Wire Terminations, Splices and Connections:

A. All connections to circuit breakers and switches and all terminations and splices in wires shall be made as noted below:

1. For #12 solid wire: Formed around binding post or screw.
2. 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.
3. 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, Scotchlok, Wire-Nut, or approved equal.

B. 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 inches of tail left out of box after splice is made up.

C. No splicing for smoke or heat detection or other fire alarm panel-reporting devices is allowed. They must be directly connected to junction box (J-box) terminals or panel relay terminals.

D. Underground splices shall be limited and only used with the approval of ASU Electrical Services Supervisor and Facilities Management (FM) electrical engineer prior to installation.

26 05 29 - Hangers and Supports for Electrical Systems

A. 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.

B. 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.

C. The use of powered-actuated devices shall be pre-approved by Arizona State University prior to use. The installing contractor is responsible for obtaining written approval of the structural support plan by the project structural engineer.

26 05 33 - Raceways and Boxes for Electrical Systems

General

A. All electrical wiring shall be placed in raceways.

B. No non-metallic cable (ex. Romex) or cords will be accepted in fixed installations. No BX, ENT, MC or similar product will be allowed. For equipment exposed to the elements, Nameplates shall be metal tags with raised lettering – No Micarta tags allowed.

C. In general, raceways are expected to be Rigid Galvanized Steel (RGS) for nominal circuit voltages equal to or greater than 600V, Rigid Nonmetallic Conduit (PVC), or Electrical Metallic Tubing (EMT) for circuit voltages less than 600V 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.

D. Suspended lights and drop-in lights in suspended ceilings may use 3/8 inch UL-approved factory-installed whips. Whip lengths shall not be more than 6 feet in length and use only with the approval of ASU Electrical Services on a job-by-job basis.

E. 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 “ unless approved by the ASU Facilities Management Electrical Services. Exception: 1/2 “ conduit is allowed for a single circuit, 20A, 120V/208V drop down a wall for a dedicated device or piece of equipment. No conduit shall be less than 1 inch for underground installations, unless approved by the ASU Facilities Management Electrical Services.

F. All raceways shall be supplied with a 100 percent sized grounding conductor and sized to the secondary loads.

G. Flexible steel conduit will be used only for chasing existing walls. Minimum size for steel flex conduit shall be 1/2 “.

H. Flexible steel conduit used in applications other than chasing existing walls shall have a maximum length of 6 feet and shall be used only with prior authorization by ASU Electrical Services. The nominal size will remain 3/4 “.

I. Underground conduits and ducts outside building that does not meet Table 300.5 NEC for burial depths shall be concrete encased or burial tape for locating 12” above conduit. Trenching, back-filling and concrete work shall be done under this division of the work and meet 95 percent compaction.

J. 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.

K. All underground electrical conduit shall have galvanized steel ELLS and sweeps. Conduits less than 2 inch have standard radius, 2 inch to 2-1/2 inch conduit diameter shall have 36-inch minimum radius and 3- inch to 5- inch conduit diameters shall have 48 inch minimum radius 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.

L. PVC conduit may be used in concrete slabs or approved hazardous locations but shall not be used as stub ups.

M. Rigid steel may be used in masonry, hollow tile wall construction and stub ups if it has two (2) layers of 20 mil rubber tape and is approved by Electrical Service Supervisor. PVC can be used inside of concrete or masonry walls.

N. Electric Metallic Tubing (EMT) may be used in furred spaces and in metal- or wood-stud walls, but not over 2 inches diameter in size. Where metallic tubing is used, connectors shall be water-tight, compression type, as required by listing for location or steel set screw where location permits. **The use of Cast fittings will not be allowed**.

O. Conduits must be kept within the furring lines established on the architectural drawings, unless conduits are shown as exposed. Conduits 2 inches and larger shall be Rigid Galvanized Steel (RGS) for conductor voltages greater than 600V and susceptible to physical damage unless otherwise approved by the Electrical Services Supervisor.

P. 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.

Q. PVC can be placed in a concrete slab on grade as long as the conduit is embedded in a slab that is minimum 6 inch thick. No conduit shall be placed between the reinforcing steel and the bottom of the slab.

R. 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**.** Exception: Underslab conduits will be allowed in existing classrooms that have slab-on-grade construction and that are being upgraded to current ASU classroom standards. All such underslab conduits shall be of materials and installation per the most recent codes adopted by the University.

S. 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.

T. All exposed conduits shall run parallel and perpendicular to building walls and ceiling.

U. Rigid galvanized steel conduit shall be installed where abuse- or damage-protection is needed.

V. Rigid aluminum conduit may be used upon specific approval from ASU Electrical Services and shall conform to the following specifications:

  1. 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.

W. 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.

X. Multi-conduit systems, 1 inch or larger, shall be supported with UL-approved conduit hangers and two steel 3/8-inch all-thread rods, supporting a minimum 14 inch long unistrut trapeze. Single conduits may be supported with minerallac hangers with appropriate sized all-thread rod supports.

Y. 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 feet apart.

Z. Where multi-conduits follow the same run as piping, trapeze hangers (unistrut) may be utilized in common with other trade piping systems, with provisions made for proper spacing and the use of UL-approved conduit clamps. Trapeze-style hangers shall have two 3/8 inch steel all-thread rod supports for each section of unistrut, minimum. Unistrut shall be 1-5/8 inch x 1-5/8 inch minimum.

AA. Suspending conduit from the bottom of the unistrut will be avoided when at all possible.

BB. 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.

Boxes:

A. All device, fire alarm, and special systems junction boxes shall be a minimum of 4”square by 2-1/8” deep. 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.**

B. Blank cover plates will be clearly and legibly labeled on both sides with permanent marker indicating feeder panel and breaker identification. Labels shall be on machine-printed tape. Use 1/4 inch wide, clear tape with black lettering. Contractor shall submit proposed labeling system for approval.

26 05 53 - Identification for Electrical Systems

A. All electrical equipment including, but not limited to, switchboards and panelboards, motor starters, disconnect switches, relays, receptacles 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.

B. Nameplate material shall be 3/32 inches 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 inches high for devices, and minimum 1⁄2 inch-high for equipment and enclosures. Nameplates shall be mechanically secured with self-tapping screws, bolts or rivets. Adhesives are not acceptable.

C. Identify all motors and other pieces of electrically operated apparatus with ¾-inch minimum height painted stencil lettering painted directly onto motor or apparatus. Color to contrast with background color.

D. Equipment, boxes and enclosures containing conductors of systems 4160V and higher shall be provided with nameplates with a red plastic laminated nameplate with 2-inch high white core letters inscribed “HIGH VOLTAGE” in 1⁄2 inch letters. The nameplate shall contain the following information; Circuit Voltage, Circuit Number, and Circuit Source.

E. 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.**

F. 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 the door.

G. All special outlets and remote-control switches shall be identified by engraving descriptive markings on flush plates.

H. All such nameplates or lettering shall be submitted to ASU Electrical Services before being secured or printed on the apparatus.

I. All room number designations shall be reviewed with Capital Programs Management Group (CPMG) and the Office of the University Architect (OUA). 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.

J. 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 05 83 - Electrical Work Serving Others

A. The contractor furnishing a piece of motorized equipment will furnish and install the motor. The electrical contractor will provide the wiring and make the connections.

B. Line control devices will be delivered to the electrical contractor by the contractor who furnished the motor and the electrical contractor will mount and connect these items.

C. Motor disconnect switches, circuit breakers, VFD’s, will be furnished, installed, and connected by the electrical contractor where required.

D. 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 work specifications where the equipment is specified to be furnished.

E. 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.

F. 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.

26 09 13 - Electrical Power Monitoring and Control

NOTE: The requirements for electrical metering and metering communication are located in DIVISION 25 36 00, Part 3 “Electric Metering”.

26 10 00 - Medium Voltage Electrical Distribution

Medium Voltage Duct Systems

A. All primary voltage systems shall be in raceways, meeting the requirements of the NEC and ASU Electrical Design Guidelines and Standards.

Minimum Requirements:

A. A minimum of two (2) rigid galvanized 5” 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. The addition of a 2” conduit shall also be installed, with mule tape, for use as a pathway for control wiring.

B. Concrete encasement shall be a minimum of 2500 PSI with an integral color tint (red).

C. Concrete-encased conduits shall be installed in pairs (i.e. multiples of two).

D. A polypropylene pull wire (2500 lbs. PSI pre-lubed) shall be provided and installed in spare 5” conduit.

E. All concrete-encased duct systems shall terminate in an underground vault except where direct entry into building transformers or switches as permitted.

F. 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.

G. 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” above concrete envelope.

H. 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. 4" galvanized rigid steel may be acceptable upon approval from Electrical Services. Rigid conduit shall be by an approved manufacturer.

I. 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.

Vaults

A. Minimum vault size shall be 16' x 10' x 8' inside dimensions. Maximum spacing of vaults shall not exceed 320’ from center to center. Smaller vaults that have no switch equipment may be acceptable upon approval from Electrical Services.

B. All roof loading shall conform to the State of Arizona Highway Specifications for H-20 loading.

C. Vaults with switchgear or where switchgear may eventually be installed shall be 12' x 12' x 7'-6" high minimum inside dimension.

D. All vaults shall have top, walls, and bottom composed of reinforced concrete.

E. 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.

F. Vault covers shall be equipped with lifting handles and shall be 48” diameter minimum hinged lid traffic rated.

G. Three horizontal runs of Superstrut Series #C300 or equivalent shall be embedded in each wall of the vault.

H. 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.

I. Each vault shall be equipped with a permanently installed hot dipped, galvanized steel ladder.

J. Ladder rungs shall be spaced 12” on centers and shall be corrugated, knurled, dimpled, coated with skid resistant material or otherwise treated to minimize the possibility of slipping.

K. Minimum ladder width between side rails shall be 12”. Side rails shall be a minimum 1 ½” x 1-½” x

3/16” thick channel size. Ladder rungs shall have a minimum ⅝” diameter.

L. The Contractor shall furnish and install two 10’ long chemical rods. The chemical rods (EPA approved, UL listed, and a 40 year life expectancy) shall 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.

M. In each vault, furnish and install vertical cable rack risers (six for each wall).

N. Risers shall be hot dipped galvanized, heavy duty, Hubbard #2225 with bolt-fastening holes spaced at 25 ½”. 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” extension. On each hook furnish and install three maple insulators.

O. 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.

P. Cells through which cable is installed shall be plugged with approved mastic and shall be watertight.

Q. Unused corners of each vault shall be provided with a 16” x 16” thin wall block out for future installations of additional duct banks.

R. All switching or transformer vaults shall be constructed in accordance with the NEC.

S. A visible ground bus shall be established in all transformer vaults. Bond all metallic piping systems at one point. A buffer ground may be used in conjunction with chemical ground rods.

T. Equipment access to all vaults shall be provided with openings large enough to remove and install equipment. A personnel door, a minimum of 48” x 90” 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.

U. Each vault shall have all the lighting connected to the emergency lighting system; lighting shall provide a minimum of 50’ candles. LED lamps are preferred. All lights shall be switched from inside the vault. Each vault shall have one duplex receptacle connected to the emergency system on dedicated 20A circuit.

V. Ventilation shall be in accordance with the NEC requirements. Natural ventilation is desirable and forced draft ventilation shall be avoided.

W. Underground vaults shall include protection of structure from water damage. h

26 12 13 - Liquid Filled Medium Voltage Transformers

A. Liquid-filled transformers shall be of the three-phase, 60 HZ, 65 DEG. C. temperature rise, self-cooled, pad-mounted distribution type rated at 45 KVA through 2500 KVA; medium- voltage 15kV and below, for operation of three-phase secondary voltage, 480Y/277V and below with all four secondary leads brought out through insulated bushings.

B. The primary side of the transformer shall be fused externally. Acceptable fuses are Bayonet fuse line - expulsion type and dry well full range current limiting fuses.

C. Transformers shall be manufactured in accordance with the latest revisions of applicable IEEE, ANSI, and NEMA specifications.

D. Wound cores shall be of the five-legged design; stacked cores shall be five-legged design. The windings shall be copper.

E. 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.

F. Oil filled transformers shall have a secondary containment capable of 150 percent of transformer oil capacity. Containment shall have a valve and nipple to allow for manual drainage.

Voltage Ratings:

A. 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 208Y/120 or 480Y/277, or as otherwise specified.

Tap Ratings:

A. Transformers shall be furnished with (2) 2-1/2% full-capacity taps above and (2) 2-1/2% full-capacity taps 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.

B. New transformers shall have an externally-operated load-break oil-immersed rotary switch. One for “A” side; one for “B” side; and one for transformer.

Transformer Impedance:

A. Transformer impedance shall be as follows:

Transformer Rating KVA	%Z
75-225	2.0%
300-500	4.5%
750 – 3000	5.75%

B. 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.

C. 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 bossed 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.

D. 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 manufacturer’s 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.

E. 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.

F. No portion of the tank or protruding appurtenances shall trap and hold water after submersion.

G. The nameplate shall be corrosion-resistant and mounted in the low-voltage compartment.

Tank-Grounding

A. The tank-grounding provision shall consist of:

B. For 500 KVA and below: Two (2) steel pads, each with 1/2 inch-13 NC tapped hole, 7/16” deep. Long enough to allow all conductors to be crimp lugged and bolted to the ground bar.

C. For 500 KVA and above; A minimum of two unpainted, copper-faced steel or stainless steel pads, 2” x 3-½”, each with the holes spaced on 1-¾” centers and tapped for ½” NC thread. The minimum thickness of the copper facing shall be 0.015 inch. Minimum threaded depth of holes shall be ½”.

D. 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.

E. Cooling fins shall be arranged so that partial covering by debris shall not materially hinder cooling.

F. Each transformer shall be provided with two hold-down clamps for securing the transformer to the pad.

G. A suitable marking inside the tank shall indicate the correct oil level at 25 degree C temperature with an externally read liquid level gauge.

H. The overall dimensions of the transformer, including cooling fins, shall be approved by ASU Electrical Services.

26 12 16 - Dry Type Medium Voltage Transformers

A. 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^{O} C. insulation. Primary transformers shall be an integrated assembly, including primary switching, transforming, and distribution sections. A minimum K-15 rated 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 nonlinear load transformers shall be shielded.

B. Transformers shall be rated at 12,470V, at 95 kV BIL with 5 taps (2 at 2-1/2% increments above and 2 at 2--1/2% increments below~~)~~ center tap at 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 the face of the transformer cabinet.

C. 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.

D. Main service transformers shall be bonded and shall have switches with fuse protection on primary and secondary sides.

High-Voltage and Low-Voltage Compartments

A. 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.

B. 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.

C. 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.

D. The locking mechanism shall accept an American Lock Company series 5260 padlock with a ⅜” x 1-⅛” shackle.

E. Doors on the high-voltage and low-voltage compartments shall be of sufficient size to provide adequate working space when open.

F. High Voltage bushing terminations shall be crimped type.

Medium Voltage Switching

A. An oil-immersed rotary switch, rated at 200 amp, 300 amp, or 400 amp shall be supplied. The switch shall be a load-break inside the transformer and load-make design and hook stick operable. Switches shall be for the following operation:

   1. Radial feed units shall have 3-position switch wired directly behind the primary bushings.
   2. Switching shall not allow for momentary de-energization of the unit
   3. **(4-position rotary switches that allow for momentary de-energization and are not acceptable).**

B. 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:

Switch A closed	Switch B closed	Transformer switch closed
Switch A closed	switch B closed	transformer switch open
Switch A closed	switch B open	transformer switch closed
Switch A open	switch B open	transformer switch closed
Switch A open	switch B closed	transformer switch open or closed

Bushing and Terminals

A. The medium-voltage phase connection shall consist of externally clamped high voltage bushing wells rated at 200 amp or 600 amp dead break integral bushing and 200 amp load break inserts conforming to ANSI C57 19.01 and C57.1200 latest revision.

B. Bushing inserts for transformers shall be rated at 200 amps at 15 KV, or 600 amp at 15KV.

C. The medium-voltage winding neutral connection (Ho) shall be such that separation between "HO" and ground can be accomplished either by the 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.

D. A fully insulated, low-voltage neutral bushing shall be provided in accordance with IEEE/ANSI C57.12.26, latest revision.

E. 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.

F. Low-voltage spades shall be copper or tin-plated copper with compressed, crimped-type connections. The dimensions and locations of the bushings shall be as indicated in ANSI C57.12.26, latest revision.

G. 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 hand hole. External replacement shall be accomplished using normal hand tools (not special) and reasonable amount of force. Welded bushing wells are not acceptable.

H. All units shall have provisions at the medium voltage entrance for attachment of a hold down bail.

I. The calculated load on load breaks, bushings, and terminals shall not exceed 80% of the rated amperage.

Accessories

A. The following accessories are required on all transformers:

1. Load rated rotary switch, externally operated
2. Liquid level gauge.
3. Pressure relief device.
4. Pressure indicator gauge.
5. Top oil thermometer.
6. Cooling fans.
7. 1” drain with valve.

Drawings, Specifications

A. Each quotation shall include the following data, and all data will be guaranteed:

1. All outline dimensions including appurtenances.
2. A drawing of the proposed nameplate (complete with all data available at the time of the quotation).
3. Rating of the transformer in KVA.
4. Exciting current at 100% and 110% of the rated voltage.
5. Excitation losses in watts at 100% and 105% of the rated voltage and 25 degree C.
6. Full load losses in watts at 100% of the rated current and 85 degree C.
7. Efficiency at full load.
8. Percentage regulation at 1.0 PF and 0.8 PF.
9. Percentage impedance "%Z" of the transformer.
10. Weight of complete transformer (including oil).
11. Gallons of oil.
12. BIL rating.

Tests

A. 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:

1. Ratio Test - phase relationship
2. Polarity

3. Resistance
4. Impedance voltage
5. Full Load Loss
6. Excitation Losses
7. Core loss
8. Exciting Current
9. High Potential (where applicable)
10. Induced Voltage
11. Production Impulse Test
12. ASU purchase order number and/or project number
13. Serial Number
14. KVA
15. Voltage
16. BIL

B. A complete oil analysis shall be provided to establish a baseline.

Testing

A. 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 500V. 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’ and 100’ 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.

B. 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:

1. Ratio test - Phase Relationship
2. Core Loss
3. Exciting Current
4. Impedance Volts
5. Load Loss
6. Applied Voltage (High Pot Test)

7. Induced Voltage

C. The completed unit assembly shall be energized and checked completely for operation before shipment.

26 13 00 - Medium-Voltage Switchgear

A. All medium voltage distribution equipment shall be rated at 5kV or 15kV minimum based on system voltage.

B. All medium voltage switchgear, circuit breakers, and fuses shall be manufactured by Eaton, S&C, or equal, compatible with the ASU Central Plant distribution system. Sectionalizing switches shall be Eaton-Cooper Vac-Pac or approved equal. All positions shall be 600 amp rated.

C. Medium voltage circuit protection shall be SEL-351 Protection Relays manufactured by Schweitzer Engineering Laboratories (SEL) or equal as approved by Electrical Services Supervisor.

D. Connections to switches shall be by standardized apparatus connectors (well bushing, bushing and cable connectors) as manufactured by Elastimold, Eaton-Cooper, or Raychem.

E. 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, Schneider, or Eaton full height metal clad switchgear with S&C renewable fuses.

26 22 00 - Low-Voltage Transformers

No transformers will be installed unless they are copper wound. Aluminum wound transformers **are not** acceptable.

26 24 00 - Switchboards and Panelboards

<u>**General**</u>

A. Bussing of the switchboard should be of sufficient capacity to accommodate the next size larger transformer bank. Main breakers should be similarly sized.

B. 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.

C. 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.

D. Feeder to switchboard may be wire in conduit or "bus way". Wires in conduit where multiple conductors per phase are required, must be pre cut so all conductors per phase are the same identical length after connection. Current capacity of "bus ways" and the size of conduit for conductors shall be such that the next size larger transformer bank can be accommodated.

E. Switchboards used 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.

F. 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.

G. Main switchboards shall be convertible unit type, dead-front, dead-rear, totally enclosed, with Eaton or Schneider circuit breakers, or equal with copper bussing only as determined by ASU

Electrical Services.

H. All switchboards shall be tested by a third party to manufacturer and NETA specifications for supplied voltage 150% of nominal.

I. Switchboards shall have main disconnects. Switchboards shall have metering per Section 25 36 00, Part 3 (Electric Metering).

J. Main switchboard supply feeders shall have a ground reference, with grounded conductor, back to the secondary side of the supply transformer.

Switchboards

A. Description: Freestanding sections 600A 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 4" 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 dead fronts with front covers bolted to sectional frame to gain access to conductor and mounting devices.

   4. Each 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. Fault values must be calculated and not dependent on transformer let through.

Panelboards

A. All buses will be copper and must be located in the rear of the panelboard cabinet.

B. 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.

C. 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 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.

D. Provide a zinc primer factory finish on the exposed trim of flush mounted panels in corridors, offices and other public spaces.

E. 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.

F. Power panelboards shall be dead front, totally enclosed, convertible type Eaton, Schneider, Square D, GE, or approved equal and shall have a main breaker.

G. Panelboard covers shall be calculated hinged with piano style hinges. (Hinge on hinge or door on door.)

H. All panelboards shall have main breakers unless approved by ASU Electrical Services.

I. Panelboards shall not be series rated or feed through design.

J. All panelboards shall have a short circuit rating and AIC bracing that exceeds the calculated fault current at the point in the system where the panel is installed. Calculations shall be made and submitted to ASU CPMG/FM Electrical Engineer and Electrical Services and indicate possible fault current. For existing panelboards, added circuit breakers shall comply with existing short circuit rating and AIC rating of the panel.

K. 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.

L. All new branch feeder circuits leaving panels shall be minimum 3/4" conduit.

M. For flush mounted or other non-accessible panels, the contractor will provide one ¾" spare conduit for each three spare breakers and one spare conduit for each three spaces. In addition, the contractor will provide one spare 1" conduit for each 20 and/or fraction of 20 panel spaces counting all possible spaces in the panel.

N. For panels of 200A capacity and over the contractor will provide one 2" 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.

O. 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.

P. All outdoor lighting panels (i.e., tennis courts, stadium, etc.), shall have HI magnetic breakers Schneider type QO130 HM, or as approved by ASU Electrical Services.

Q. All panels shall contain a ground buss.

R. 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.

S. 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.

T. The contractor will provide a spare empty panel next to all new distribution panels for future use.

U. 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:

    1. "By room number:"
    2. M - main distribution panel.
    3. E - emergency lighting and power panels.
    4. L - lighting panels i.e., 277/480V.
    5. P - power panels i.e., 120/208V.

V. Combinations may be used such as:

    1. ML - main lighting panel.

2. MP - main power panel.
3. ME - main emergency panel.
4. MCC - Motor Control Center.

W. 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:

1. Type L = Lighting Panel.
2. Floor 0 = Basement.
3. Room 22 = Room Number.
4. Location B = Second panel from left.

X. Panels in corridors shall follow the same sequence [i.e., L-C (0,1,2) (A,B,C...)].

26 24 19 - Motor Control Centers

A. Due to the availability of variable frequency drives (VFD's) the need for motor control centers has reduced. The use of new motor control centers will require the approval of CPMG, Facilities Management (FM) Electrical Engineer, and FACMAN Electrical Services Supervisor.

B. Starters should be grouped into motor control centers. Individual starters, except in isolated cases, are to be avoided.

C. Motor Control Center(s) shall be 600V class suitable for operation on a three phase, 60 Hertz system, manufactured by Eaton, Schneider, or GE.

D. 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.

E. Busses shall be braced for 65,000A RMS symmetrical interrupting current (AIC) minimum at 480-volts.

F. 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.

G. 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.

H. Wiring shall be NEMA Class II, Type B.

I. Provide a separate source disconnect switch for each circuit brought into a starter or relay enclosure from a voltage source external to the starter.

J. 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 ensure positive silver-to-silver contact with both sides of the bus.

K. Thermal magnetic devices with solid state overload shall be provided to obtain specified short circuit rating.

L. Provide three solid state overload units sized for 125% of the motor nameplate full-load current rating.

M. External operating handle of circuit disconnect shall be interlocked with door so handle must be in "Off" position before the 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.

N. Each starter should have a hand-off-automatic (HOA) switch coordinated with the automation system.

O. All control power will be in the form of a control power transformer for each starter AND must originate within the cubicle of the MCC such that the removal of the cubicle or turning the cubicle 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.

P. 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.

Q. 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 manufacturers recommended size, based on the individual motor nameplate rating or as recommended by the NEC.

R. Motor starters shall incorporate over-current, over-voltage, under-voltage and phase loss motor protection. Starters using replaceable heaters shall not be used.

S. Coordination regarding motors, starter control, interlocks and automation controls is necessary.

T. Cross references to equipment lists and common equipment designations and identification is required on the drawings.

U. All motor control centers will have a monitor modular meter to display the total volts, 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.

V. All Motors 10 horsepower and above shall be an Electronically Commutated Motor (ECM) or equipped with a variable frequency drive (VFD). 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.

W. Starters shall conform as follows:

   1. 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.
   2. Equipment starters with control transformers shall have fuse protection on the secondary side of the transformer.
   3. 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.
   4. Red and green LED or LCD illuminated status lights shall be included (green shall indicate "run").

26 27 26 - Wiring Devices

General

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.

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.

Receptacles

A. Duplex receptacles shall be U-ground, rated for 125V, 20A, back and side wired with a thermoplastic nylon body. Receptacles shall be equipped with a full length steel back plate (strap).

B. Duplex receptacles with ground fault interrupter characteristics shall be U-ground, rated for 125V, 20A, 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.

C. Single receptacles feeding critical, or high amperage loads shall be twist-lock type with cord cap to match.

D. Approved manufacturer: Hubbell, Bryant, Arrow Hart, Pass and Seymour, or approved equivalent.

E. All cover plates shall match the color of the electrical device. Stainless steel plates shall be used where subject to physical damage. Device and cover plate color shall identify type of power source:

   1. BLUE – Standby Power
   2. RED – Emergency Power

F. Where weatherproof mounting is required per NEC, 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.

G. Labels shall be on machine printed tape, ¼ inch wide, clear tape with black lettering or Contracting color to color of cover plate. Contract shall submit proposed labeling system to ASU Electrical Services for approval.

H. 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.

I. Contractor shall submit specifications on cord caps to ASU Electrical Services for approval.

J. No outlets or temporary electrical distribution shall be installed adjacent to or near water sources unless GFCI protected. All outlets or temporary electrical distribution on the exterior of a building or area that is exposed to the outside weather conditions must also be GFCI protected.

K. The elevation of each outlet must be specified or indicated on the drawings.

L. Receptacles and devices shall not be connected for feed through, but pigtailed in box for circuit continuation.

M. Tumbler switches shall be flush mounted wall type tumbler switches and shall be silent mechanical type rated at 20A 120/277V AC industrial grade, back and sided wired and with a nylon toggle.

N. If more than one 20A single-phase circuit is installed in a conduit with a common neutral, the size of the neutral conductor shall be a #10 THW minimum.

Switches

A. 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

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.

A. 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.

B. Safety disconnect switches shall be furnished and installed as a disconnecting means for all motors and equipment as required by Code or this standard.

C. 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.

D. Switches shall have a handle whose position is easily recognizable and is padlockable in the “OFF” position.

E. Switches shall be furnished with cover interlocks with defeat mechanism for maintenance; fused where required.

F. Switches shall be rated from 30 to 1200A; 250V AC, DC; 600V AC; 2 or 3 pole; copper terminals; with manufacturer supplied ground bus.

G. Switch enclosures shall be NEMA 1 for general purpose where installed indoors; NEMA 12 (dust-tight and oil-tight) where installed in industrial areas, NEMA 4X stainless steel where installed in corrosive areas, NEMA 3 where the disconnect switch is installed outdoors, or listed for use in location where installed.

H. 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:

EX-1
EXHAUST FAN #1
NORMAL POWER
100A, 480V, 3-PHASE, 3-WIRE
FED FROM MCC4P CIRCUIT 4

26 28 23 - Enclosed Circuit Breakers

A. 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.

B. Circuit protection should be in the form of circuit breakers mounted in suitable panels with ON, OFF, TRIPPED indication.

C. Disconnect switches shall be used where necessary at remote motor locations. Motor starting controls shall be centralized if a sufficient number is involved.

D. Control centers shall be Schneider, Eaton, GE or as approved by ASU Electrical Services.

E. 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.

F. All disconnects for starters shall have positive lockout in the "OFF" position.

G. All motor control centers will have a monitor modular meter to display the total volts, 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.

H. All Motors 10 horsepower and above shall be an Electronically Commutated Motor (ECM) or equipped with a variable frequency drive (VFD).

I. 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:

  1. Single phase motors shall have a manual starter with integral overload protection.
  2. Three phase motors shall have full voltage magnetic across the line starters, unless a current limiting starter is specified.
  3. Thermal dip switch with selectable overload protection shall be provided on all three legs.
  4. Auxiliary contacts shall be provided as required for control interlocks.
  5. Equipment starters with control transformers shall have fuse protection on the secondary side of the transformer.
  6. 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.
  7. Red and green LED or LCD illuminated status lights shall be included (green shall indicate “run”).

26 29 23 - Variable Frequency Drives

Variable Frequency Drives (VFD’s) shall have a microprocessor based control system, high frequency IGBT semiconductors 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.

The VFD shall have a backlight liquid crystal display with minimum ¼” characters. The display shall indicate the setup, operation and monitoring of drive to be displayed, such as volts, amps, speed, frequency kilowatts and kilowatt hours with run, local or remote control indication. Acceptable units are ABB, Eaton, Graham, or approved equivalent.

<u>Operating Parameters</u>

A. Hand/Start will start the drive (assuming safety interlocks are closed) with the speed of drive controlled manually via "+" and "-" buttons.

B. Off/Stop shuts down drive regardless of other commands.

C. Auto/Start - drive will start and stop the motor via external contact closure. The speed is controlled via the building automation signal (4-20 mA, 0-10V DC, etc.).

D. Program password to perform any change.

<u>Setup Applications</u>

A. 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 startup.

Drive Features

A. Current limit circuits shall be adjustable from 0-110% of the VFD's size factory default motor current.

B. Constant torque start to allow constant torque start to full torque of motor on acceleration until drive reaches set point.

C. Three phase output current measurement and software measures output on all three phases.

D. The phase to ground is instantly detected and has an adjustable trip.

E. The VFD shall have integrated electronics, with thermal motor protection.

F. VFD shall calculate the motor temperature based on current, frequency and run time, and allows for changing cooling conditions as speed and load vary.

G. The VFD shall have a DC line reactor to filter and reduce harmonics reflected back into the building power system.

H. The VFD shall have voltage surge protection on the line side of drive.

I. Acceleration and deceleration shall be used to shape voltage and current curves and should automatically be contoured to prevent drive tripping.

The carrier frequency should employ IGBT's for high switching frequencies to prevent audible motor noise and to ensure that motor current is practically sinusoidal, minimizing Total Harmonic Distortion (THD).

J. The VFD shall have critical frequency lockouts to avoid specific frequencies which cause mechanical resonance problems.

K. The VFD shall have built-in communications. Approved communication protocols include JCI N2 (when connecting to a Metasys system) or BACNET.

L. The voltage input for nominal + or - 10% adjustment should be from 200V through 240V range for 220V systems and 400 through 480V range for 440V three phase systems.

M. The VFD shall have three interlock contactor bypasses with an HMCP 65,000 AIC breaker to ensure that the drive power is removed from the VFD bus.

N. 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 41 00 – Facility Lightning Protection

Description

Due to the possible consequences of a lightning strike, there are cases where the need for lightning protection shall be given serious consideration. These include the following:

- Facilities essential to public health and safety.
- Open areas that contain large crowds.
- Continuity of mission critical services.
- Tall isolated structures, including antenna.
- Buildings containing explosive, flammable, or hazardous materials that could be detrimental to the environment.
- Hospital-based facilities and laboratories.
- Buildings that are historical structures or represent irreplaceable cultural heritage and artifacts.
- Buildings or structures that experience high lightning flash frequency.
- Buildings or structures that are subject to regulatory or insurance requirements requiring lightning protection.

Although the National Electrical Code (NEC) and most local building codes do not require lightning protection for buildings or structures, Arizona State University (ASU) could benefit from installing lightning protection.

To accurately determine the need for Lightning Protection, Design Professionals shall evaluate the planned project based upon the following aspects:

- **Vulnerability of a structure or building:** This is determined based on building or structure's height, the area of its footprint, and the flash density of the region based on meteorological records.

- **Overall Risk:** This is determined based on the Life Safety factors and potential ease of evacuation of a building, the overall surroundings, height of building, construction materials, access to fire hydrants, installed fire suppression systems, equipment infrastructure, back- up systems, the combustibility of contents and the estimate of financial exposure.

Factors That Affect Lightning Risk

- **Equivalent collection area:** The building rooftop's area including all equipment, attachments and the height of the structures that may impact the potential of a lightning risk.

- **Lightning ground flash density:** The annual number of flashes per kilometer squared can be obtained from a ground flash density map.

- **Surrounding structures:** The building location impacts the likelihood of a lightning strike. As an example, buildings isolated on a hilltop or surrounded by trees or other structures taller than the planned building.

- **Contents of the building:** The general use of the structure and the associated contents. The type of contents may increase the risk of property damage during a lightning strike.

- **Type of construction:** A steel structure and a wooden building hold different risks for lightning strike and damage caused by lightning.

Based upon these factors listed above, Design Professionals shall conduct a **Lightning Risk Assessment** to determine the potential hazards for buildings and structures planned and designed at Arizona State University.

To determine the Lightning Risk Assessment for buildings or structures at ASU, Design Professionals shall utilize NFPA 780, "Annex L".

How to Assess the Lightning Risk to a Building and Its Occupants

NFPA 780, "Annex L" provides two protocols for evaluating if a particular building or structure requires Lightning Protection:

- **Simplified Risk Assessment,** which calculates the tolerable lightning frequency and compares it to the annual threat of occurrence calculated according to Section L.3 of this document.

- **Detailed Risk Assessment,** comparison of the calculated risk of loss due to lightning with the tolerable level of risk the university is willing to accept.

These assessments will determine the estimated risk of lightning discharges and the likelihood for causing a loss of life or injury, loss of historical significance, loss of service(s), and probable economic losses.

Evaluation of risk factors will help Arizona State University make an informed decision regarding lightning protection for the building or structure.

After performing a Lightning Risk Assessment, and it is determined that Lightning Protection will be required for the project, the Design Professional shall use the following as the Basis of Performance for a Lightning Protection System at ASU:

Design Standard

The entire lightning protection system shall be designed and installed in accordance with:

A. National Fire Protection Association (NFPA) Standard for the Installation of Lightning Protection Systems, NFPA 780 (2020 Edition)

B. Underwriters' Laboratories, Inc. (UL) Installation Requirements for Lightning Protection Systems, UL 96A.

C. Lightning Protection Institute (LPI) Standard # 175 (2020 Edition).

Products:

All materials shall comply in weight, size, and composition with UL96-A and NFPA-780 lightning protection material code requirements for this type of structure and with the requirements of a nationally recognized testing laboratory. All equipment shall be properly listed and labeled.

All materials shall be copper, bronze, or stainless steel. Aluminum components shall be used in locations where system components are mounted to aluminum surfaces to avoid galvanic corrosion of dissimilar metals.

The system to be furnished shall be the standard product of a manufacturer regularly engaged in the production of lightning protection equipment and shall be the manufacturer's latest approved design. The equipment shall be UL listed and properly UL labeled.

All equipment shall be new, and of a design and construction to suit the application where it is used in accordance with accepted industry standards and UL and NFPA requirements.

A. ACCEPTABLE MANUFACTURERS

1. A/C Security Lightning, LLC (www.aclightningprotection.com)
2. Advanced Lightning Technology, Ltd. (www.altfab.com)
3. Harger, Inc. (www.harger.com)
4. Independent Protection Company, Inc. (www.ipclp.com)
5. Preferred Lightning Protection (www.preferredlp.com)
6. Thompson Lightning Protection, Inc. (www.tlpinc.com)
7. Approved Alternative Manufacturer

B. MATERIALS:

1. Class I materials shall be used for systems on structures not exceeding 75 feet in height and Class II materials shall be used for systems on structures exceeding 75 feet above grade.

2. Copper shall be of the grade ordinarily required for commercial electric work, generally designated as being 95 percent conductive when annealed. Aluminum conductors shall be of electrical grade aluminum.

3. Lightning protection materials shall be coordinated with building construction materials to assure compatibility. Aluminum lightning protection materials shall not be embedded in concrete or masonry, installed on or below copper surfaces, or used where contact with the earth is possible terminating 18” above grade level minimum. Copper lightning protection materials shall not be installed on aluminum surfaces. Copper system components within 2 feet of chimney exhausts shall be tin coated to protect against deterioration.

4. Air terminals shall be placed at an interval not exceeding 20 feet along ridges and around perimeters and not more than 24 inches from ridge ends, roof edges and the outside of corners of protected structures. On mid-roof sections, additional air terminals shall be located at intervals not exceeding 50 feet.

5. Air terminals shall also project a minimum of 10 inches above protected areas or objects.

6. Strike termination devices shall be provided to place the entire structure under a zone of protection.

7. Cable conductors shall provide a two-way path from strike termination devices horizontally and downward to connections with the ground system. Cable conductors shall be free of excessive splices and sharp bends. No bend of a conductor shall form a final included angle of less than 90 degrees nor have a radius of bend less than 8 inches. Structural elements and design features shall be used whenever possible to minimize the visual impact of exposed conductors.

8. Conductors shall maintain a horizontal and/or downward path to the ground and shall be free of excessive splices and sharp bends. No bend shall form an included angle of more than 90 degrees or have a radius of less than 8 inches. Fasteners shall be placed on each run of exposed conductor at intervals not exceeding 3 feet. Down conductors shall be spaced at intervals averaging not more than 100 feet around the perimeter of the structure. A structure shall never have fewer than 2 down conductors. In the case of structural steel frame buildings, cable down conductors may be omitted. Roof conductors shall be instead connected to the structure’s steel frame at intervals averaging not more than 100 feet around the perimeter. Connection to the steel frame will be made with bonding plates which provide a minimum of 8 square inches of contact.

9. Cable down conductors may be concealed within the building construction or enclosed within PVC conduit from roof to grade level. Down conductors shall be spaced at intervals averaging not more than 100 feet around the protected perimeter of the structure. In no case shall any structure have fewer than two down conductors. Where down conductors are exposed to environmental hazards at grade level, guards shall be used to protect the conductor to a point 6 feet above grade.

10. Roof penetrations required for down conductors or for connections to structural steel framework shall be made using through-roof assemblies with solid rods and appropriate roof flashings. The roofing contractor shall furnish and install all materials required at roofing penetrations of the lightning protection components and any additional roofing materials or preparations required by the roofing manufacturer for lightning conductor runs to assure compatibility with the warranty for the roof. (Note: The roofing contractor will be responsible for sealing and flashing all lightning protection roof penetrations as per the roof manufacturer’s recommendations.)

11. In the case of structural steel frame construction, cable down conductors may be omitted and roof conductors shall be connected to the structural steel frame at intervals averaging not more than 100 feet around the protected perimeter of the structure.

12. Fasteners, nails, screws, or bolts shall be of suitable configuration for the intended application and of the same material as the conductor or of electrolytically compatible materials. Galvanized or plated steel fasteners are not acceptable.

13. Connectors and splicers shall be of suitable configuration and type for the intended application and of the same material as the conductors or of electrolytically compatible materials.

14. Ground Terminations: Each downlead shall terminate in a ground connection below finished grade. The rods shall be located a minimum of 1 foot below grade, a minimum of 2 feet from the foundation and extend a minimum of 10 feet vertically into the earth. In instances where structural steel framework is utilized as down conductors, the perimeter columns shall be grounded at intervals averaging not more than 60 feet.

15. Ground terminations suitable for the soil conditions shall be provided for each downlead conductor. Where the structural steel framework is utilized as main conductors for the system, perimeter columns shall be connected to the grounding system at intervals averaging 60 feet or less on the protected perimeter. For any structure in excess of 60 ft. in vertical elevation above grade, a ground loop interconnecting all ground terminals and other building grounded systems shall be provided.

16. Common interconnection of all grounded systems within the building shall be accomplished using main size conductors and fittings. Grounded metal bodies located within the calculated bonding distance shall be bonded to the system using properly sized bonding conductors.

17. Surge suppression shall be provided at every system entrance to the structure to prevent massive lightning overvoltages from entering the structure. Additional surge protection for internal electronic equipment may be determined through cost-benefit analysis.

C. INSPECTION AND CERTIFICATION:

1. The Lightning Protection Contractor shall be certified as a Master Installer by the Lightning Protection Institute.

2. Contractors shall develop and follow their own aerial lift and fall protection program requirements. Refer to the following for ASU requirements:
https://www.asu.edu/ehs/documents/contractor-safety-project-management-info-sheet.pdf
https://www.asu.edu/purchasing/forms/Service_Provider_Acknow.pdf

3. Upon completion of the installation, the contractor shall furnish the Master Label issued by Underwriters Laboratories, Inc. for this system.

4. The installed system shall be inspected by an ASU building inspector for final acceptance,

5. The installed system shall be inspected by an ASU Fire Marshal Inspector for final acceptance.

26 50 00 - Lighting

General Lighting

All lighting shall comply with California's Title 24 Lighting section unless otherwise specified.

http://www.energy.ca.gov/title24/2013standards/supporting_docs.html

All Lighting shall be serviceable without requiring the removal of permanently installed equipment or building structures/ features. Approval from FACMAN Electrical services supervisor is required for lighting installed at heights requiring scaffolding or lifts to access.

Lighting Limitations

A. Arizona Revised Statutes Title 49, Chapter 7 places some limitations on outdoor lighting fixtures.

B. **THESE PROVISIONS WILL BE ENFORCED.**

C. All lighting must be designed with energy conservation in mind.

D. Light fixtures in wet or damp locations, especially around bathtub and shower areas shall be installed such that water or moisture cannot enter any parts of the fixtures and shall be marked "Suitable for Wet Locations".

Lighting Intensities

A. For general illumination of building spaces, the lighting design shall be based on this section and the latest edition of the IES Lighting HandBook and IECC.

B. It is suggested that general lighting be concentrated near whiteboards to give increased intensities on the whiteboards, while preventing glareh.

C. In making lighting calculations due allowances must be made for the reflectivity of walls, ceilings and floors.

D. Color schemes must be known before calculating design intensities.

E. 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.

F. Areas such as halls and large rooms with more than one exit should have three and four way switching.

G. All light fixtures must be readily accessible for re-lamping unless they are a dedicated LED fixture.

H. If installing T-LED tubes, no ballasts shall be used and both tombstones shall be wired hot.

I. When re-lamping a fixture and the ballast is removed, an approved label shall be applied to the interior of the fixture identifying that the fixture has had its ballast removed and the tombstones are hot.

J. 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 re-lamping.

K. 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.

L. Lighting accessible from above must have the appropriate catwalks, etc. to meet the requirements of ADOSH.

M. 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.

N. 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.

O. Fixtures in staircase and entrances are to be located such that re-lamping does not require tall ladders, scaffolds at angles or ladders exceeding ADOSH limitations. In general, fixtures should be installed with 8’ feet as a maximum.

P. Lights, in general, shall be LED. 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, Energy Innovations, CPMG A/E and OUA.

Q. The preferred color temperature is 4000K unless otherwise specified by the DP or ASU.

R. The CRI of all LED tubes and fixtures shall be greater than 80.

S. 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.

T. Fixture schedules are to be placed on the electrical drawings and not in the specifications.

U. This section includes general design parameters for conceptual calculation for electrical and lighting loads, in watts per square foot and foot candles.

Area of Activity/Utilization	Foot-Candles
Library reading rooms	50
Calculating rooms	50
Drafting rooms	75
Accounting rooms	50
Proofreading rooms	75
Classrooms	50
Laboratories	75
Seminar rooms	50
Offices	50
Shops	50
Toilet rooms	20
Kitchens	30
Locker rooms	20
Store rooms	20
Corridors, Academic and Offices - 25, Dormitory	10
Stairs, Academic and Office - 25, Dormitory	10
Machine room	30
Building entrances, outside	30
Building entrances, inside	same as corridors
Parking Structures and Lots	3.0
General Site Lighting	1.5

Open parking facilities	2.0

V. Supplemental local illumination shall be provided for wherever required to give the following local intensities:

Area/Activity	Foot-candles
Shop work at machines or benches	75
Displays	75
Demonstration tables or areas	60
Elevator Equipment Rooms	30

Lamps

A. Remote mounted drivers are not allowed.

B. LED lamps are the preferred lamp. They should be frosted and installed without the need of a ballast.

  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. (Fluorescent lamps should be avoided where possible).

C. The installation of LED lamps and fixtures should strive for the longest warranty, lowest wattage, appropriate kelvin temperature and CRI’s of 80 or above whenever possible.

D. All lamps shall be new and operating at time of acceptance of the electrical work.

E. Approved manufacturers are General Electric, Revolution, Green Creative, Lunera, LG, Sylvania, Phillips, or approved equal.

F. If fluorescent lamps are approved, the installation shall be type FO25T8 and 4100 Kelvin in color, low mercury type at ASU at the Tempe Campus, and other campuses as directed by Capital Programs Management Group.

Lamp Ballast (when needed)

A. Remote mounted ballasts are not permitted.

B. For all LED installations, ballasts are not permissible.

C. 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.

D. 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.

E. Ballast shall have an average lamp current crest factor below 1.4.

F. Ballasts shall meet minimum efficiency standards of Public Law No. 100-357.

G. National Appliance Energy Conservation Amendments of 1988.

H. Ballast shall withstand line transients as defined in ANSI/IEEE C62.41, category A.

I. Ballasts shall have a power factor of 90% or above.

J. Ballast shall not contain Polychlorinated Biphenyls (PCBs).

K. Ballast shall meet the requirements of the Federal Communications Commission Rules and Regulations, Part 18, Class A.

L. All ballasts shall be internally protected.

M. Ballasts must be quiet operating and provisions must be established for removing and replacing any noisy ones.

N. The noise level shall not exceed 34db when measured 6' from installed fixture.

O. 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.

Lighting Fixtures

A. Lighting fixtures shall be LED equipped with 0-10V controls. The color temperature shall be 4000K with a CRI of 80 or greater unless otherwise specified.

B. When approved, fluorescent lighting fixtures shall be (2) tube energy saving type, and double switched for energy conservation and selected by an Electrical Engineer on the basis of the intended use of each space and any instructions which may be given by the DP.

C. The fixture selection shall be checked and approved by ASU Electrical Services, Energy Innovations, and OUA.

D. Fixtures should be easy to maintain and replacement shades available from open stock.

E. Where strip lighting is used, it is recommended that the rows be arranged parallel with any exposed ceiling beams.

F. Flush and recessed fixtures installed in furred ceilings shall be provided with junction boxes located at least 1' foot from fixtures.

G. Wiring from junction box to fixture shall be high temp. Wire, as recommended by NEC, 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 the ceiling. (The only Exceptions are UL listed assemblies).

H. In concealed locations, junction boxes shall be integral with fixture.

I. 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.

J. All fixtures shall incorporate a grid, screen, panel or other device which will prevent the falling of any tube which may become dislodged.

K. All light fixture lenses shall be acrylic plastic, minimum 0.125 inch thickness.

L. 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.

Corridor Lighting

A. 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.

B. 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.

Lighting Controls

A. All lighting controls shall be in compliance with California’s Title 24 Lighting guidelines.

   1. All lighting controls shall support an open protocol standard of Modbus and/or BACNET in order to ensure interoperability between systems. Please coordinate with FACMAN and Energy Innovations regarding system selection.
   2. System preference shall be given to the current campus standard. If an alternate system is chosen, it should have the ability to integrate into the current lighting system front-end or allow other systems to be able to integrate to it. ASU FACMAN and Energy Innovations shall be consulted regarding this option.
   3. System manufacturers to be evaluated include, but are not limited to, Crestron, Wattstopper, Lunera, Leviton, Lutron, GE, Cooper, etc.
   4. The system shall be cost effective and supported by the manufacturer for at least 10 years.

B. The decision on whether to install a wired or wireless system shall be coordinated with OUA, Energy Innovations and the Facilities Management Electric Shop Supervisor. The preferred method is a wired solution.

C. The system shall be easy to maintain. Training shall be offered as part of any deliverable.

D. The system shall be able to control individual fixtures and/or zones depending on the decision of the DP and the lighting designer. Top-End Trim and demand response shall be required features of the system.

E. The use of time clocks for lighting controls is not permitted.

F. The use of occupancy sensors and daylight harvesting shall be required.

G. Other benefits offered by the system manufacturer shall be evaluated and offered to the University as possible enhancements to the system.

26 51 00 - Interior Lighting In Unfinished Areas

A. All unfinished areas are to meet code required minimum lighting levels.

B. All future finished space shall have power capacity and breaker space provided in the feeder panels and distribution panels.

C. Telephone, automation and other signal raceways, including fire alarms serving unfinished but finishable areas, are to be completed through other finished areas.

D. Attics and other spaces not finishable are not required to have these raceways except for the fire alarm system.

E. LED lighting in attics and service chases, etc. shall be provided. An LED fixture shall be installed and not just an LED lamp.

F. Switches are to be located at each access using three and four way switching where two or more accesses exist.

G. All fixtures must be easily re-lamped, particularly in attics and mechanical chases without the use of ladders, hoists, scaffolds, or where catwalks must be installed.

26 52 00 - Emergency Lighting

Emergency lighting systems shall be installed wherever required for reasons of personnel safety and per code.

A. Review each installation with ASU Electrical Services on availability of emergency power.

B. ASU Tempe campus has in place a 600V/480V emergency power system throughout the tunnel system which is in the process of being upgraded to a 4.16kV distribution system and has selectively located 600V distribution panels.

C. New buildings must be designed to get emergency power from the 4.16kV emergency power generator system installed at the Central Plant or Combined Heat and Power Plant (CHP). 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. The emergency power will be taken off of the emergency power distribution system grid supplied from Central Plant or CHP and will be connected to the alternate power source at the AETS.

D. The emergency power system from Central Plant can be described as a quadrantile distribution system. The 4.16kV emergency power supplied from Central Plant is converted to a 600V emergency power distribution system at various locations in each quadrant on campus. All new installations to be 4.16kV to 480Y/277V to a distribution service sized at 60% of building loads. The 600V/480V system shall be reduced to usable voltage for the individual building requirements ahead of the AETS. The AETS and the step down transformer will be located at each individual building.

E. At the ASU Tempe campus, emergency lighting systems shall be separate from normal lighting panels, but will be fed from normal power through transfer switching and backed up by the Central Plant or CHP emergency distribution system.

F. The ASU 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 CPMG.

G. Do not use battery operated exit lights or signs, or fluorescent battery packs for space lighting at the ASU Tempe campus.

H. Use self-luminous exit signs whenever emergency lighting power is not available in the area.

I. All exit lights and signs shall be on the emergency lighting system.

J. Use long life LED lamps in all exit lights. Fixture shall have a cast iron housing.

K. 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.

L. 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.

M. All raceways for the emergency lighting systems shall be separate from all other raceway conductors.

N. 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.

O. A minimum of 50 foot candles of lighting shall be provided in electrical vaults and at the vertical plane of main switchboards and motor control centers.

P. Both normal circuits and emergency circuits shall be provided in a redundant fashion.

Q. A dedicated 120V 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.

R. Emergency lights are not to be switched, except in equipment rooms, tunnels, and vaults. Circuits are to be connected directly to the emergency panel board, with the above exceptions.

S. All emergency lighting circuits and lighting control diagrams are to be shown on the drawings.

26 56 00 - Exterior Lighting

A. 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 per OUA Site Furnishings package that is submitted to each DP upon commencement of the project. All exterior lights are to be controlled by the current lighting controls standard for that campus. Please coordinate with the ASU Facilities as to which system is currently being supported.

B. Meet the following criteria:

1. 4000 Kelvin color temperature.
2. Color rendering index (CRI) : >70.
3. Recommended Footcandle Levels:

Area	Min. Horiz.	Min. Vert.	Uniformity Ratio
Parking Facilities			
Driving Surfaces, parking areas, vehicle transaction areas.	1.0*	.5**	10:1 (Max/Min)***
Elevator lobbies, pedestrian transaction areas, stairways.	1.5*	.75**	5:1***
Vehicle entries and exits – Day	50.0*	25.0**	10:1***
Vehicle entries and exits – Night	1.0*	.5**	10:1***
Pedestrian stair on outdoor pedestrian way	5.0*	2.5**	4:1***
Parking Lots			
Asphalt	.5*	.25**	15:1 (Max/Min) ***
Concrete	1*	.5**	15:1***
Transaction areas	1*	.5**	15:1***

* measured at FFE
** measured at 5' above FFE
*** spacing to be no greater than 6'0"

Area	Horiz. Avg	Vert. Avg	Vert. Min.	Horiz. Avg.
Pedestrian Ways and Building Exteriors				
Building Entries Uncovered	1.0 (min.)*	1.0**		
Building Entries Covered	1.5*	.75**		

Area	Horiz. Avg	Vert. Avg	Vert. Min.	Horiz. Avg.
Ped. Areas/Bikeways	.5*		0.2**	4.0*(min.)
Plazas	.3*	.1**		

Ramps and Stairs	.4*	.2**

* measured at FFE
** measured at 5' above FFE

C. All exterior lamps and fixtures shall be LED.

D. Any exterior fixture, where applicable, should be equipped with a NEMA 7-pin socket.

E. When adding any exterior lighting, a photometric lighting layout shall be performed detailing the expected foot candles and lighting impact to its surrounding area.

F. Illumination levels shall be code complaint and in line with the current campus standard.

G. Poles required for exterior lighting shall contain hinged bases.

DIVISION 27 - COMMUNICATIONS

27 51 29 – Emergency Blue Light

Description

Blue light stanchions are an integral component of the strategy for overall project security. All ASU owned and operated facilities and site development projects are required to provide exterior mounted blue light stanchions. For leased and/or remote facilities, establishment of the responding Police Department jurisdiction will determine the requirement for Blue Lights stanchions.

Design Requirements

A. Blue light locations are based on the following criteria:
   1. Along key path of travel routes (400' maximum linear spacing).
   2. At pedestrian decision points (i.e., walkway intersections, parking lot pay stanchions, rideshare pick-up/drop-off locations, etc.)
   3. At every parking structure level access point (i.e., stairwell landings, elevators, pedestrian entry locations, etc.).
   4. Provide unobstructed views to the station and strobe light. Consider the visual impacts from built structures, plant material and signage elements.
   5. Provide unobstructed access to the call button. The location must meet all 2010 ADA standards for accessibility.

B. Blue light stanchions can be any combination of freestanding stanchion, wall-mount stanchion, wall-mount call box or flush mount panel with remote strobe.

C. The following are approved station models:
   1. **Gai-tronics Tower stanchion, Model 234**
   2. **Gai-tronics Wall-mount stanchion, Model 234WM-202**
   3. **Gai-tronics Wall-mount hands-free telephone, Model 393AL-001AD**
   4. **Gai-tronics Flush-mount panel, Model 397-001**

D. Tower stanchion color to be RAL 8012 Red Brown.

E. "Emergency" lettering to be 3M, gold color.

F. Tower stanchions to include fixed focal length video cameras on all four sides or as determined by the Blue Light Review Committee. The approved camera model is:
   1. **Axis Communications, Model AXIS Q3515-LVE 22mm**

G. Provide a direct network connection from all cameras to ASU PD.

H. Locate stanchions to maximize camera coverage. Where blind spots exist, install supplemental building or stanchion mounted cameras to provide complete site and/or building exterior coverage.

I. Data and power lines from each stanchion shall be home run to the closest building MDF/IDF room. Do not daisy chain data and/or power cables from one stanchion to another.

J. Cable runs over 295 feet will require a repeater.

K. Provide two (2) 1¼" conduits for data and one (1) ¾" conduit for power.

L. Connect blue light stanchions to emergency backup power.

M. Refer to ASU UTO Telecommunications and Design Standards V3.0 for further technical information:
   https://asu.service-now.com/kb_view_customer.do?sysparm_article=KB0010867

Submittal Requirements

A. To submit a CPMG/OUA project for review, download the Blue Light Location Review Application form located in **Dropbox/ASU Blue Light Committee/Guidelines & Application Form**

B. Submittals shall include the following:

1. **PDF site plan** indicating blue light stations, model numbers, any additional camera locations. The plan should indicate all paths of travel along with proposed landscape, building and/or site elements that affect visibility.
2. **Context plan or aerial image** showing the immediate area surrounding the project site. The plan should include existing adjacent blue light locations (if any), sidewalks/walkways, roadways, parking lots, major landscape elements, buildings and/or other structures.
3. NOTE: For parking structures, a **ground floor and typical floor plan** for the remaining levels (where similar).
4. **Perspective rendering or 3D model** illustrating proposed equipment locations if available OR as requested by the committee.

A. All documents shall be submitted for review by ASU PM or DM.

27 51 30 – Two-Way Communication System

A. Shall be provided at the landing serving each elevator or bank of elevators on each accessible floor that is one or more stories above or below the level of exit discharge in accordance with International Building / Fire Code 2018 Edition.

B. Exceptions:

1. Not required on floors provided with ramps.
2. Not required at the landings serving only service elevators that are not designate as part of the accessible means of egress or serve a part of the required accessible route into a facility.
3. Not required at the landing serving only freight elevators.
4. Not required in group I-2 or I-3 facilities.

C. System Requirements.

1. Deferred Submittal sent to asufire@asu.edu for Review and Permitting.
2. Provide communication between each required location and the fire command center or a central control point location (ASU Police Dispatch).
3. Shall indicate both audible and visible signals.
4. Directions and approved signage for use shall be posted adjacent to the two-way communication system.
5. No prerecorded message shall be installed as part of the equipment. There shall be no delay in communication through the two-way communication system and emergency responders.
6. Final acceptance testing through EHS Fire Safety and Prevention.

27 51 31 – Emergency Responder Radio Coverage System (ERRC)

A. Installation Requirements:

1. Deferred submittal separate from Fire Alarm submittal sent to asufire@asu.edu for Review and Permitting.
2. New Buildings or Structures 50,000 square feet and larger, regardless of stories, and or height.
3. New Buildings or Structures with a Basement or other Subterranean spaces.
4. The Fire Code Official has determined that the Buildings or Structures have been constructed in a manner or with the materials that are likely to cause interference with emergency response communications.

5. Follow the EHS Fire Safety and Prevention guideline for ERRC Systems.
6. Final Acceptance testing through EHS Fire Safety and Prevention and ASU Police Department.

B. Exceptions:

1. New Buildings or Structures that do not meet the above requirements are still required to provide the pathway through the Building or Structure and provide all cabling for future system use.
2. Fire Code Official can determine for outlying ASU areas if the ERRC System will be required or not based on the communication signal and other specific factors

27 53 19 - IN-BUILDING WIRELESS DISTRIBUTED ANTENNA SYSTEM

PART 1 - GENERAL

1.1 DISTRIBUTED ANTENNA SYSTEM

A. General Requirements: The ERCES shall be a single broadband radio frequency (RF) infrastructure that supports a wide range of current and future wireless technologies, protocols, and services. It shall be able to supply wireless services to multiple applications concurrently.

1. The system shall fully support first responder and two-way radio communications. All necessary licensing and patent agreements shall be included to utilize this technology as part of this work.
2. The ERCES shall include an In-Building system. The exact requirements for the exterior system require an RF site survey.
3. The ERCES system should provide a minimum signal strength of -95 dBm within 95% of the required coverage area and sufficient to provide not less than a DAQ of 3.4 or an equivalent SINR
4. The ERCES system should provide a minimum signal strength of -95 dBm within 99% of areas designated as critical areas by the fire code official and to provide note less than a DAQ of 3.4 or an equivalent SINR.
5. Contractor shall ensure that ubiquitous coverage is provided throughout the facility on all levels.
6. All DAS components shall be the latest components available on the market. All components shall be new and have been manufactured within 6-months of installation.

B. Equipment, Infrastructure, and Components: The system shall include horizontal cable, antennas, power supplies, transceivers, media converters, head-ends, and all other necessary components required to distribute wireless services throughout the building. Signal cables and connected components shall be protected against transient-voltage surges by suppressors and absorbers designed specifically for the purpose in required areas.

1.2 ASU EHS Fire Safety and Prevention Requirements:

A. Emergency Responder Coverage Enhancement Systems are required in the following:

1. New buildings or structures 50,000 square feet and larger, regardless of stories, and or height

2. New buildings or structures with a basement or other subterranean spaces
3. The Fire Code Official has determined that the buildings or structures have been constructer in a manner or with the materials that are likely to cause interference with emergency response communications

B. Exceptions:
   1. New buildings or structures that do not meet the above requirements are still required to provide the pathway through the buildings or structure and provide all cabling for future system use
   2. Fire Code Official can determine for outlying ASU areas if the ERCES will be required or not based on the communication signal and other specific factors

1.3 PUBLIC SAFETY SYSTEMS

A. Active DAS
   1. Alll campus ERRCS will be active systems utilizing a centralized head end, feeding fiber to adjacent buildings to remote amplifiers.
   2. In the event an existing active DAS can no longer be expanded, contractor will coordinate use of new head end within building for BDA/Master Unit

B. Arizona State University Personnel:
   1. The ERCES shall include all necessary head-end equipment to rebroadcast all Local Public Safety and any Federal Law Enforcement radio traffic. The Contractor shall coordinate Public Safety requirements including equipment and radio frequencies, etc. with each authority.
   2. System requirements shall meet Police Department’s current wireless communication standards.
   3. Contractor shall provide equipment and components recommended by Manufacturer based on proposed solution.

C. Fire Department and EMS:
   1. The ERCES shall include all necessary head-end equipment to rebroadcast all Fire Department and EMS Two-Way Radio Communications System.
   2. The Contractor shall coordinate Public Safety requirements including equipment and radio frequencies, etc. with each authority.
   3. System requirements shall meet Fire Department and EMS’s current wireless communication standards.
   4. Contractor shall provide equipment and components recommended by Manufacturer based on proposed solution.

1.4 SUMMARY

A. The Contractor shall be responsible for providing a DAS that will support all first responder RF signals.

B. The Contractor shall be responsible for a system warranty for a period of two years from final testing and acceptance.

C. Should a building pass the minimum requirements set forth, passive infrastructure will be furnished and installed in the event a ERCES is needed in the future. Components to include coaxial cabling, connectors, splitters, couplers, tappers and antennas. Cable is to be terminated & tested to ensure integrity of cable installed.

    1. In the event all active & passive infrastructure is deployed, and at time of substantial completion the building passes minimum requirements, ASU EHS personnel & RWC may choose not to energize some or all of the system

D. The Contractor shall include the following information in the bid response.

    1. First Responder frequencies, Coordination, and Requirements
    2. Procurement Options
    3. System Monitoring & Maintenance and Support Options
    4. PS DAS Equipment Room
    5. PS DAS Head-End (if applicable), Infrastructure, Equipment, Remote Units, Antennas
    6. PS DAS Support Systems – Mechanical, Electrical, Plumbing and Fire Suppression
    7. DAS Manufacture Certification
    8. FCC GROL License
    9. NICET Level 2 Certification
    10. iBwave Level 3 Certification

E. The ERCCS shall meet all coverage and capacity requirements for the facility based on the highest occupancy allowed by code. The coverage shall be ubiquitous throughout the venue in public and non-public areas. Minimum signal strength into and out of the building as follows:

    1. Minimum inbound signal strength shall be sufficient to provide usable voice communication throughout the coverage area. The inbound signal level shall be a minimum of -95dBm throughout the coverage area and sufficient to provide not less than a Delivered Audio Quality (DAQ) of 3.4 or an equivalent Signal-to-Interference-Plus-Noise Ratio (SINR)
    2. Minimum outbound signal strength shall provide usable voice communications throughout the coverage area. Outbound signal level shall provide not less than a DAQ of 3.4 or an equivalent SINR

F. Contractor shall provide all detailed coordination of antenna placement for approval by Owner and Manager.

G. The term “provide” used throughout this specification and drawings shall mean “furnish, install, test, certify, support, and maintain”.

H. Coordinate project schedule, installation schedule, phasing and any other requirements deemed necessary with Construction Manager and all necessary Trades to ensure successful completion of work.

I. Phasing, temporary distribution/equipment, cut-over and implementation shall be coordinated with Owner and Manager.

J. This specification is not intended to contain proprietary information or requirements based on any specific manufacturer or system. Any proprietary information included in this specification is unintentional.

K. This specification is intended to establish the minimum performance criteria requirements for providing a ERCES. The contractor shall coordinate all system and performance requirements and criteria with all ERCES users to ensure signal strength, coverage, capacity, and other requirements are all maintained. This includes coordination with the AHJ and Public Safety Officials.

L. This specification outlines general wireless requirements for implementing a ERCES used for supporting applications such as first responder radios.

M. Design, furnish, install, and configure a turnkey ERCES, system management and monitoring software. Work shall include all necessary fiber optic backbone, distributed antenna system components and installation thereof required including raceway, cable, cable terminals, transceivers/media converters, amplifiers, equipment, fireproofing, fire suppression, etc. for a fully operational and functional ERCES.

N. The ERCES scope of work shall be for a complete and fully functioning DAS system including but not limited to wireless surveys, technical design, procurement, installation, AHJ coordination, and full support of system. These elements of this scope shall include all necessary components and infrastructure such as ERCES head-end, fiber optic backbone, and remote units.

O. This work shall include onsite installation, equipment and submittals.

P. An onsite wireless/RF survey shall be provided to establish existing signal strengths. This study shall be completed on all levels and areas and as necessary to finalize locations of antennas as well as validate signal strength and coverage after installation and during commissioning.

Q. The Contractor shall coordinate project construction schedule with the Construction Manager to establish milestone dates for substantial completion, that affect occupancy certificates, system completion, commissioning, and turn-over.

R. The ERCES wireless coverage and signal strength shall be field-tested and verified, certified, and guaranteed upon installation against design requirements.

S. The ERCES shall support first responder frequencies.

T. Contractor shall provide all necessary coordination, requirements and contracts/lease agreements with AHJ. These shall include but not be limited to equipment room and all ERCES technical requirements necessary to interface with base stations, transport the signal, and transmit the signal throughout building and exterior.

U. The installation of the distributed antenna system shall comply with all local building codes, and applicable rules and regulations of the authority having jurisdiction (AHJ), FCC, BICSI, IFC, NEC, NFPA, UL, and other industry standards, codes, and methods.

V. Provide cabling, fiber optic and/or coax, to support the ERCES from the Head-end to remote units and/or intermediate communications room.

    1. Where a ERCES is added to an existing ERCES fiber optic cabling between buildings will be provided by ASU

W. Extent of ERCES work is indicated by Division 27 Specifications and Technology drawings (for reference of equipment rooms) and schedules and is hereby defined to include, but not by way of limitation, the provisions of:

1. All infrastructure shall be provided as part of this work including but not limited to, cable, cable terminals, room fit-out, etc. unless noted otherwise in this specification and drawings.
2. Dedicated fiber optic backbone cable between remote units and intermediate communications room and the head end equipment.
3. Cable terminations and terminals including but not limited to wiring panels/blocks, patch panels, fiber optic terminals and panels, and outlets/jacks.
4. Patch cords, jumper cables, and cross-connect cables to interconnect wiring terminals, antennas, and electronic equipment.
5. Connection from power supplies to electrical equipment
6. Provide ERCES alarming as required under IFC 510.4.2.5
7. Coordination and connection of ERCES system to fire alarm control panel.
8. Grounding and bonding of all metallic hardware components to the nearest telecommunications grounding bus (TGB) bar including but not limited to equipment chassis, metallic cable sheaths and shields, cable terminals, etc. Grounding shall include insulated bonding conductors, lugs, and attachment hardware.
9. All physical cable management hardware including, but not limited to: “J-hooks” in accessible ceiling areas, “D-rings” on backboards, horizontal managers in racks and cabinets within all communication rooms, etc.
10. Fire stopping as required.
11. Testing of system, components, and infrastructure as noted by specification, drawings, and applicable industry standards.
12. Testing of all grounding systems as noted by specification, drawings, and applicable industry standards.
13. Labeling of all system equipment, components, hardware, cable, and terminations with mechanically printed labels.
14. Preparation and submission of product data, shop drawings, testing reports, as-built drawings, and cabling documentation as required in this specification.
15. Construction and Installation warranties.
16. Manufacturer components, channel and solutions warranties.
17. Installation and testing of all system and components.
18. Onsite administrative and user training.
19. Manufacturer training of components.
20. Preparation of maintenance plan recommended by system Manufacturer.

1.5 CONTRACTOR QUALIFACTIONS

A. Contractor must submit the following requirements at time of award:

1. ADRF Public Safety certification
2. Line Sweep certification
3. FCC GROL License

4. NICET Level 2 certification
5. iBwave Level 3 certification

1.6 ACRONYMS AND ABBREVIATIONS

A. Provided below is a general list of typical acronyms and abbreviations:
   1. AHJ: Authority Having Jurisdiction
   2. BDA: Bi Directional Amplifier
   3. BICSI: Building Industry Consulting Services International
   4. CW: Continuous Wave
   5. DAS: Distributed Antenna System
   6. DAQ: Delivered Audio Quality
   7. DL: Down Link
   8. DTF: Distance to Fault
   9. EPO: Emergency Power Off
   10. FACP: Fire Alarm Control Panel
   11. FCC: Federal Communications Commission
   12. GROL: General Radio Operators License
   13. NEC: National Electrical Code
   14. PoE: Power over Ethernet
   15. POI: Point of interface
   16. ERCES: Emergency Responder Coverage Enhancement System covers the common term of ERRC Emergency Responder Radio Coverage
   17. OTDR: Optical Time Domain Reflectometer
   18. RF: Radio Frequency
   19. RL: Return Loss
   20. f: Regional Wireless Cooperative
   21. TRWC: TOPAZ Regional Wireless Cooperative
   22. SINR: Signal to Interference Noise Ratio
   23. UL: Up Link
   VSWR: Voltage Standing Wave Ratio

1.7 SUBMITTALS

A. General Description and Requirements:
   1. The Contractor shall submit submittals consisting of product data for approval. Partial submittals will not be accepted without prior written approval from the Owner Representative. Coordinate all submittal dates with the project team.
   2. Review of the Submittals by the Owner Representative is for purposes of tracking the work and contract administration and does not relieve the Contractor of responsibility for any deviation from the Contract Documents, or from providing equipment and/or services required by the Contract Documents which were omitted from the submittals.
   3. No portion of the project shall commence nor shall any equipment be

procured until the prefabrication submittals have been approved in writing by the Owner and Owner Representative. All installations shall be in accordance with the Contract Documents.

4. Contractor shall submit all test equipment's factory calibration showing the equipment is in the manufactures recommended time frame for calibration.
5. Submittal shall include the persons performing the work, manufactures certification for test equipment, data collection tools, and DAS equipment being installed.
6. All deferred submittals shall be sent to asufire@asu.edu for review and permitting through EHS Fire Safety and Prevention
7. ERCES system requires stand-alone permitting as a unique system. ERCES system submittal should not be bundled into any other system's permit submittal

B. Product Data: The ERCES Product Data Submittal shall be submitted for review and approval by Owner and Manager prior to starting any work. Information shall include detailed manufacturer's specifications for each component to be installed. Submittal shall include a list every component with Manufacturer's part numbers referenced, and, if available, Manufacturer data sheets with features, options, ratings, and performance. Product numbers and options to be used shall be highlighted with color marker.

1. Component List: Provide complete submittal component list at the beginning of the submittal package. Component list shall identify each component name, manufacturer, and specific product/part number. All part numbers shall clearly indicate special options, color, accessories, etc.
2. Cut-Sheets: Submit manufacturer's cut-sheets on all components listed within this specification and corresponding appendix. All components and parts being used shall be highlighted in color or clearly underlined on cut-sheets to distinguish specific product/part numbers, options, colors, accessories, etc.
3. Product Substitutions: This specification is intended to be performance based, thus requirements and products noted are benchmarks. The Contractor may substitute manufacturers and models that may be more cost effective or readily available. All substitutions shall meet or exceed the minimum functional, physical, and technical specifications. Acceptance of such substitutions is at the discretion of the Owner and Manager. Additionally, the requirements of Division 1 Specifications shall apply and may supersede requirements noted herein.
4. Warranty Information: Provide all warranty information as described in this specification section for review and approval.
5. Installer Certificates: Provide manufacturer certification signed by manufacturer certifying that installers have been trained to install all components of the system and comply with manufacturer's requirements. iBwave Certified Level 3 required. FCC GROL License required. Nice Level 2 Certified required. Cable and Antenna Analyzer Certification required.

C. Coordination Data: A detailed equipment and component schedule with supporting manufacturer cut-sheets shall be developed for all components and equipment for architectural, engineering, and construction coordination. These documents shall include electrical requirements (volts, phase, amps, power consumption, receptacle configuration, etc.), UPS requirements, heat dissipation, temperature operating range, target operating temperature, physical equipment sizes (LxWxH, rack units, racks, cabinets, panels, etc.).

D. Shop Drawings: The ERCES Shop Drawings shall be submitted for each "construction phase configuration" and "final configuration" prior to starting any work for review and approval by Owner and Manager. Additionally, Shop Drawings shall be used for coordination with Manager and Trades by this installer. Information shall include all drawings necessary to present installation intent including plans, enlarged plans, elevations, sections, details, and interface to other work or systems.

1. Legend Sheet: Provide drawings including descriptions of all abbreviations and symbols.
2. One-Line Diagrams: Provide drawings that indicate backbone and horizontal cable infrastructure, antennas, and all equipment. Drawings shall include relevant information such as room numbers, panel numbers, cable and raceway requirements.
3. Floor Plans: Provide scaled plan drawings based on architectural background indicating device and equipment locations including point of interface (POI) antennas, cable, antennas, backbone and horizontal cable distribution, panels, conduits, back- boxes, junction boxes, etc. Additionally, provide wiring diagrams for indicating cable origination and routing.
4. Enlarged Plans: Provide enlarged scaled plan drawings for equipment layouts in communications rooms.
5. Elevations: Provide scaled drawings for elevations of all equipment layouts in communications rooms, equipment racks, and panels.
6. Details: Provide detail drawings as required to show components requiring greater detail. This should include various antenna types and mounting configurations.
7. Labeling: Provided documentation of all labeling schemes for conduit, back-boxes, junction boxes, antennas, panels, cable, terminations, patch panels, cross-connects, patch panels, etc.
8. Test Results: Provide all final RF test results in a table or matrix as well graphically on plan drawings. Test results shall indicate the signal strengths and DAQ levels.

E. As-Built Drawings: The ERCES As-Built Drawings shall be submitted to Owner after completing work. As-Built Drawings shall indicate final installation of system. Information shall include all drawings necessary to present final installation intent including plans, enlarged plans, elevations, sections, details, and interface to other work or systems.

1. Legend Sheet: Provide drawings including descriptions of all abbreviations and symbols.
2. One-Line Diagrams: Provide drawings that indicate backbone and horizontal

cable infrastructure, antennas, and all equipment. Drawings shall include relevant information such as room numbers, panel numbers, cable and raceway requirements.

3. Floor Plans: Provide scaled plan drawings based on architectural background indicating device and equipment locations including point of interface (POI) antennas, backbone and horizontal cable distribution, panels, conduits, back-boxes, junction boxes, etc. Additionally, provide wiring diagrams indicating cable origination and routing.
4. Enlarged Plans: Provide enlarged scaled plan drawings for equipment layouts in communications rooms.
5. Elevations: Provide scaled drawings for elevations of all equipment layouts in communications rooms, equipment racks, and panels.
6. Details: Provide detail drawings as required to show components requiring greater detail. This should include various antenna types and mounting configurations.
7. Labeling: Provided documentation of all labeling schemes for conduit, back-boxes, junction boxes, antennas, panels, cable, terminations, patch panels, cross-connects, patch panels, etc.
8. Test Results: Provide all final RF test results in a table or matrix as well graphically on plan drawings. Test results shall indicate the signal strengths and DAQ levels.

F. Field Test Reports: Indicate and interpret test results for compliance with performance requirements of installed systems. Grid test shall be required using a calibrated spectrum analyzer or equivalent grid testing tool. Calibration certificate should be provided in the submittal.

G. Commissioning:

1. Check-List: Contractor shall create and submit a detailed checklist for commissioning system equipment and components. The list shall be submitted for Owner review. System commission shall include the following categories.
    a. Procured Components Validation (with serial numbers, etc.)
    b. Physical Installation and Location
    c. Equipment Connectivity and Inter-Connectivity
    d. System Setup and Operation
    e. Wireless Surveys
    f. Testing
    g. RWC/TRWC and ASU BDA registration
2. Report: The Contractor shall complete commissioning of the system and issue a final report. Commissioning shall be performed upon completion of system, and after its testing and retuning. Report shall be completed and finalized by the Contractor prior to system acceptance by Owner. A formal report shall be generated that includes sign-off and notes of all items.
3. Documentation: Contractor shall provide the AHJ with all required

documentation for permitting. A copy of the final system settings, grid report, and isolation testing. Shall be left onsite at the BDA.

H. Warranties: The Contractor shall fully warranty on all parts, components, and labor for the entire duration of the ERCES agreement with Owner. Warranty period shall start based on acceptance by Owner upon completion, testing and acceptance of the installation by the project team.

I. Documentation: All documents submitted by Contractor including product data, submittals, as- built, test results, drawings, reports, etc. shall be provided in electronic (pdf) format.

J. BDA Registration: The contractor must register the BDA with both the RWC/TRWC and ASU. A copy of the registration shall be included in the closeout package.

1.8 QUALITY ASSURANCE

A. Installer Qualifications: The installation supervisor for the installation of units required for this Project must be an experienced installer who is an authorized representative of the ERCES manufacturer.

1. Contractors shall have at least five (5) years of successful installation experience with projects utilizing wireless systems including ERCES.
2. The Contractor shall have a fully staffed office with technical installations support personnel within the state boundary of the project.
3. The company shall be a certified installer of the ERCES manufacturer, and shall provide a 2-year warranty on installation/applications.
4. The company shall be a certified installer of structured cabling systems, and shall provide a 2-year warranty on installation/applications.
5. The Contractor shall have a professional engineer licensed to practice in jurisdiction where Project is located and who is experienced in providing engineering services of similar scope. The Contractor’s design shall be reviewed, signed, stamped, and sealed by the engineer.
6. The contractor shall provide an add alternate price for yearly maintenance beyond the warranty period on an annual basis.

B. Manufacturer and Product Qualifications

1. Provide products from manufacturers whose products of similar types, capacities, and characteristics have been in satisfactory use in similar projects for not less than five (5) years.

C. Products and Substitutions: Other manufacturers' products complying with requirements may be considered. All manufacturer solutions, products components and/or substitutions shall be submitted at bid time for review and acceptance by Owner. Cost changes including additions or deductions, shall be submitted for all items.

D. Alternates: All alternates requested or proposed by the Contractor shall be submitted at bid time for review and acceptance by Owner. Cost changes including additions or deductions shall be submitted for all items.

E. Electrical Components, Devices, and Accessories: These shall be listed and labeled as defined in NFPA 70, NEC, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use. All materials shall be Underwriters Laboratories (UL) Listed unless otherwise noted or required by AHJ.

1.9 CODES AND STANDARDS

A. All work including materials and installation shall conform to all applicable sections of currently adopted editions of the codes and standards listed below or the codes, standards and specifications published by the organizations listed below:

1. State and local codes.
2. ANSI: American National Standards Institute (ANSI).
3. ANSI/EIA/TIA-526: Standard Test Procedures for Fiber Optic Systems.
4. ANSI/EIA/TIA-568-C: Commercial Building Telecommunications Cabling Standard.
5. ANSI/EIA/TIA-569-A: Commercial Building Standard for Telecommunications Pathways and Spaces.
6. ANSI/EIA/TIA-606A: Administrative Standard for Commercial Telecommunications.
7. ANSI/EIA/TIA-607: Commercial Building Grounding and Bonding Requirements for Telecommunications.
8. ASTM: American Society for Testing and Materials
9. BICSI TDM Telecommunications Distribution Methods Manual (current edition).
10. BICSI Wireless Design Reference Manual (current).
11. City of Tempe Article II – Public Safety Radio Amplification System
12. EIA/TIA TSB67: Transmission Performance Specifications for Field Testing of Unshielded Twisted-Pair Cabling.
13. Federal Specification Compliance: Comply with applicable requirements of FS W-C 586, “Electrical Cast Metal Conduit Outlet Boxes, Bodies, and Entrance Caps.”
14. ICEA: Insulated Cable Engineers Association
15. IFC 2018: Section 510 and Appendix J
16. ISO/IEC 11801: International Standard on Information Technology – Generic Cabling of Customer Premises.
17. NEC: Applicable local electrical code requirements of the authority having jurisdiction, and the NEC as applicable to electrical boxes and fittings, cable tray systems, and grounding and bonding, pertaining to systems, circuits and equipment.
18. NESC: National Electrical Safety Code
19. NEMA: Applicable requirements of NEMA Stds/Pub No.’s OS1, OS2 and PUB 250 pertaining to raceways, outlet and device boxes, covers, and box supports.
20. NEMA: NEMA Stds/Pub No. VE 1 “Cable Tray Systems”
21. NFPA-70/NEC: National Electrical Code.
22. NFPA-70B: “Recommended Practice for Electrical Equipment Maintenance” pertaining to installation of cable tray systems.

23. UL Compliance.
24. UL Compliance: Applicable requirements of UL 50, UL 514-series, and UL 886 pertaining to electrical boxes and fittings.
25. UL Compliance: Applicable requirements of UL Standards No.'s 467, Electrical Grounding and Bonding Equipment", and 869 "Electrical Service Equipment", pertaining to grounding and bonding of systems, circuits and equipment. In addition, comply with UL Std 486A, "Wire Connectors and soldering Lugs for Use with Copper Conductors." Provide grounding and bonding products which are UL-listed and labeled for their intended usage.

B. Where there is a conflict between the code and the contract documents, the code shall have precedence only when it is more stringent than the contract documents. Items that are allowed by the code but are less stringent than those specified on the contract shall not be substituted.

1.10 PROJECT CONDITIONS

A. Prior to submitting a proposal, the Contractor shall inspect the Contract Documents, and shall become fully informed as to laws, ordinances, and regulations affecting the project. The Contractor shall immediately bring to the Owner and Manager's attention, in writing, any existing condition or statute that contradicts, is in conflict with, or negates the Contract Documents. Failure of the Contractor to become fully informed as to all above mentioned items shall in no way relieve the Contractor from any obligations with respect to its proposal.

B. The Technology Drawings schematically depict locations of major equipment and components. Field conditions and coordination with related trades may warrant relocations of field devices. No additional compensation will be allowed due to these revisions.

1.11 DELIVERY, STORAGE, AND HANDLING

A. Equipment and components shall be delivered in factory-fabricated containers or wrappings, which properly protect equipment from damage.

B. Equipment and components shall be handled carefully to prevent damage including but not limited to breakage, denting or scoring of surfaces, etc. Do not install damaged units or components; replace with new. Replace damaged units or components following installation with new ones.

C. Equipment and components shall be stored in original packaging in a dry, clean, well-ventilated space, and shall be protected from construction traffic, weather, moisture, soiling, humidity, and extreme temperatures.

1.12 SEQUENCING AND HANDLING

A. All work shall be reviewed and coordinated with the project team prior to commencing.

B. ERCES, infrastructure, and equipment are sensitive to environmental conditions including but not limited to temperature, dirt, dust, and water. The contractor shall ensure the storage and installation of all system components are sequenced and scheduled accordingly to prevent any damage, loss of performance, and warranty voiding. All mis-installed components shall be replaced with new parts and re-installed at the contractors' expense.

C. Installation shall be coordinated with Structural, Electrical, HVAC, Plumbing, Fire Protection, and other trades to eliminate disruption and/or conflict with other systems.

D. Installation of ERCES and infrastructure shall be sequenced with other work to minimize possible damage and soiling during the remainder of construction.

1.13 COORDINATION

A. The Contractor shall:

1. Coordinate layout and installation of ERCES equipment, antennas, and cable with other construction that penetrates ceilings or is supported by them, including but not limited to light fixtures, HVAC equipment, fire-suppression-system components, and partition assemblies.
2. Coordinate location of cabling, antennas, and associated concealment with other trades.
3. Coordinate location of equipment in the communications rooms and spaces with the Owner and Manager.

1.14 WARRANTY

A. The Contractor shall be responsible for coordinating warranty requirements and/or issues with their preferred DAS Manufacturer and sub-contractors. The Contractor shall ensure that a warranty is in place for replacement of components to ensure uptime of system. Typical warranty requirements are listed below but it's the Contractor's sole responsibility to obtain warranties of their system.

B. The warranty requirements shall comply with Division 1 and as noted in this Section. Any conflicts shall meet the most stringent required unless approved otherwise by Owner.

C. A two (2) year warranty on the Work shall be provided by the Contractor. If, within two (2) year after the date of final acceptance by Owner of the installation. Warranty period shall start based on acceptance by Owner upon completion, testing and acceptance of the installation by the project team.

D. Warranty response shall be as listed in Section 1.12 Response Time.

E. If system operation is not fully restored during the warranty period within 24-hours, the Owner reserves the right to require the Contractor to provide on-site manufacturer's service technicians at no additional cost.

F. The Owner reserves the right to expand or add to the system during the warranty period using firm(s) other than the Contractor for such expansion without affecting the Contractor's responsibilities, provided the expansion is done by a qualified and authorized dealer or agent for the equipment of the system being expanded.

G. Contractor shall guarantee coverage and fix any coverage gaps or incorrect signal strengths at no cost to the Owner. The Owner will not accept the system at turn-over until the system has been field tested, verified, certified and guaranteed that coverage limits as specified and as required by code have been fulfilled.

1.15 RESPONSE TIME (Warranty and Maintenance)

A. Response time to failure of systems, equipment and/or component during warranty period and maintenance periods shall be within twenty-four (24) hours of placed call.

PART 2 - PRODUCTS

2.1 ACTIVE EQUIPMENT (BDA, UPS, REMOTE BDA)

A. Manufacturers: Subject to compliance with requirements, products and solution shall be provided the following Manufacturers:

1. ADRF

2.2 DEDICATED ANNUNCIATOR

A. Manufacturers: Subject to compliance with requirements, products and solution shall be provided the following Manufacturers:

1. ADRF
2. DAS Alert

2.3 DONOR ANTENNA

A. Manufacturers: Subject to compliance with requirements, products and solution shall be provided by one of the following Manufacturers:

1. ADRF: AD-PA-700-900-DIN-X
2. Gamma Nu: F16V28DHFB
3. Ventev: VHG-VL3015-ODNF

2.4 SERVING ANTENNAS

A. Manufacturers: Subject to compliance with requirements, products and solution shall be provided by one of the following Manufacturers:

1. Westell
2. Commscope
    a. Omni-directional must be low profile (slim-line) for aesthetics

2.5 BACKBONE & DISTRIBUTION CABLING

A. Manufacturers: Subject to compliance with requirements, products and solution shall be provided by one of the following Manufacturers. Distribution cabling required to be the color red:

1. RFS (Donor, 2HR Rated & Distribution Coaxial Cabling)
2. Gamma (Donor & Distribution Coaxial Cabling)
3. Corning (Fiber Optic Cabling)

4. Vextra (Alarming Category 6 Cabling)

2.6 DISTRIBUTED ANTENNA SYSTEM COMPONENTS

A. The system components shall meet the following requirements:
B. Bi-Directional Amplifier:
    1. Must be Class A.
    2. Provide multiple connections among the primary RF services frequency bands (e.g. 700 – 900 Mhz) to accommodate proposed public safety services and ASU channels.
    3. Primary ERCES head-end equipment shall include a data network interface for connecting to Management and Monitoring System. Interface shall be 10/100/1000 Mbps Ethernet (RJ45).
C. Remote Bi-Directional Amplifier(s):
    1. Provide Remote Distribution Units or Expansion Units at Intermediate Communication Rooms and above ceilings as necessary to transition from single-mode fiber optic backbone to horizontal antenna cables (horizontal distribution).
    2. Provide multiple connections among the primary RF services frequency bands (e.g. 700 – 900 Mhz) to accommodate proposed public safety services and ASU channels.

2.7 SIGNAL TRANSMISSION COMPONENTS

A. The signal transmission components shall be of the following types and meet the following requirements
B. Cables:
    1. Types:
        a. Single-Mode Fiber Optic
        b. Cat. 6 UTP
        c. 1/2" 50-ohm Coaxial
        d. 7/8” 50-ohm Coaxial
    2. Ratings: All cable shall be UL-Listed for use in the locations they are to be installed.
C. Terminals and Connectors: Equivalent to cable type and performance capabilities. Contractor shall provide connectors and terminals approved to work and comply with Manufacturer’s system.
D. Cable Hangers: “Clic” Self-Locking Hangar or approved equal.
E. Transmissions methods and components vary by manufacturer, so this information shall be submitted in detail at bid time for review and acceptances by Owner.

2.8 UNINTERRUPTABLE POWER SUPPLY (UPS)

A. All ERCES equipment and components shall be connected to a UPS system to maintain uptime during failover of normal power. This includes head-end, remote equipment, and any other equipment/components requiring power, etc.

B. Contractor shall coordinate all ERCES power requirements with electric installer to ensure requirements are included with equipment provided by others or shall provide them.
C. Contractor shall interface ERCES equipment as hardwired to dedicated electrical circuit.
D. In the event building is on backup generator, minimum two (2) hours of battery backup is required for the ERCES.
E. UPS shall provide twenty-four (24) hours of battery backup for full run time of the ERCES.
F. Battery systems shall be contained in a NEMA 3R or higher rated cabinet
G. Emergency Power Off (EPO) shall be provided for ERCES. The EPO shall be located in the Fire Command Center and clearly labeled with protection to prevent accidental activation

2.9 DEDICATED ANNUNCIATOR PANEL

A. All ERCES active equipment shall be connected to an annunciator for monitoring & reporting to the Fire Alarm Control Panel (FACP). This includes head-end, remote equipment, and UPS.
B. The Annunciator shall be located adjacent to the FACP and tied into the FACP
C. System monitoring to include the following automatic supervisory and trouble signals:
    1. Loss of normal AC power supply (Supervisory)
    2. System battery charger(s) failure (Trouble)
    3. Malfunction of the donor antenna(s) (Supervisory)
    4. Failure of active RF-emitting device(s) (Trouble)
    5. Low-battery capacity at 70% reduction of operating capacity (Trouble)
    6. Failure of critical system components (Supervisory)
    7. The communications link between the fire alarm system and the ERCES (Trouble)
    8. Oscillation of active RF-emitting device(s) (Supervisory)

PART 3 – EXECUTION

3.1 EXAMINATION

A. The following examination tasks shall be performed by Contractor:
    1. Examine pathway elements intended for cable. Check raceways, cables trays, and other elements for compliance with space allocations, installation tolerances, hazards to cable installation, and other conditions affecting installation.
    2. Examine rough-ins for antenna to verify actual locations of cable connections before antenna installation.
    3. Examine walls, floors, roofs, equipment bases, and roof supports for suitable conditions where equipment is to be installed.
    4. Proceed with installation only after unsatisfactory conditions have been corrected.

5. Provide detailed site survey to determine best cable routing and location of antennas.

3.2 INSTALLATION

A. General:

1. This Section describes the installation locations for the products and materials, as well as methods associated with the ERCES and wireless installation portions of the Project. These Specifications shall be followed during the course of the installation.
2. The Contractor shall examine areas and conditions under which ERCES infrastructure is to be installed. Notify Owner and Owners Representative in writing of conditions detrimental to proper completion of the work. Do not proceed with work until unsatisfactory conditions have been corrected in a manner acceptable to the installer.
3. The Contractor shall be knowledgeable of work to be performed by other trades and take necessary steps to integrate and coordinate their work with other trades.
4. The Contractor shall be responsible for furnishing all materials as specified herein for a complete ERCES.
5. The Contractor shall verify space requirements and locations before starting cable installations and terminations. Inappropriate conditions shall be immediately reported to Construction Manager, Owner and Owner’s Representative prior to initiating installation.
6. All ERCES and communications infrastructure shall be installed in an aesthetically pleasing fashion. All surface raceway in new buildings must be approved by the Owner and Owner’s Representative
7. All communications infrastructure shall be installed for optimal performance.
8. All ERCES and communications infrastructure shall be installed to allow for easy additions, moves, and other changes in the future.
9. Final labeling scheme for all ERCES and communications components shall be coordinated with the Owner and Engineer during the shop drawings process, prior to initiating work. Labeling scheme shall include but not be limited to communications rooms, cabinets, racks, cable terminal blocks and patch panels, antennas, outlets, cables, etc.
10. Construction within communication rooms must be substantially complete before the installation of the ERCES and communications cabling. This includes, but is not limited to, the installation of plywood backboard, cable tray or ladder rack, electrical outlets, light fixtures, sprinklers and ductwork. All walls shall also be painted before the installation.
11. All components noted in this section and drawings shall be provided and completely set up and installed. This includes but is not limited to Cable, Terminations, and Cable Managers.
12. The Contractor is required to coordinate their efforts with the other trades and sub- contractor who may be working within the same vicinity to avoid conflict and lost time.

13. The Contractor shall supply all necessary tools, equipment, accessories, safety equipment, protective clothing, etc., as customary for the craft and necessary for the installation.
14. Where applicable, the Contractor shall verify existing cable fill in riser conduits before installation of additional cables so as not to exceed 40% cable fill. where additional cables to be added will exceed the 40% cable fill the contractor should notify the owner and have additional pathways installed.
15. The contractor shall not install any component in a manner or condition that will void manufacturer and/or contractor warranty. Any such conditions that prevent an acceptable install shall be immediately reported to Construction Manager or General Contractor, Owner, and Owner's Representative prior to initiating installation. All mis-installed components will be removed and replaced with new, appropriate components at the Contractor's expense. No additional cost will be submitted to Owner.
16. All equipment shall be installed in a neat and workmanlike manner, arranged for convenient operation, testing and future maintenance.
17. Communication rooms must be free from dust, dirt, and other foreign materials before the installation of any termination hardware or the termination of fiber optic cables. The door to the communication rooms must be installed and closed during termination.

B. Raceway Installation: The following procedures shall apply to raceway installation:

1. Fire seal all raceway penetration and openings to maintain fire rating after communications cables are installed.
2. Provide labels on all communications pull-boxes and junction-boxes.
3. Identify conduits at cable tray end by architectural room number.
4. Cable shall not be installed in any cable tray. Cable shall be installed in J-hooks attached to the exterior of the cable tray.
5. Roof pathway shall be in conduit installed on roof blocks.

C. Cable Installation: The following procedures shall apply to cable installation:

1. All distribution cable, backbone cable, horizontal cable, and antenna cable must be plenum rated.
2. All ERCES cables routed within communications rooms shall be bundled to provide a neat and organized appearance. This includes horizontal and vertical cables routed on cable tray, d-rings, vertical cable managers, equipment rack cable managers, etc. Cables shall be bundled using only manufacturer and industry approved wire ties with tensions that do not deform and damage cable resulting in loss of transmission or performance. Any methods used shall not exceed manufacturer or industry standard recommendations for that cable type.
3. Install cables concealed in accessible ceilings. Install cables according to manufacturer's recommended installation practices using approved hangers at a maximum spacing of every 48-inches.

4. Do not lay cable on suspended tile ceiling, ductwork, piping, conduit, or other building equipment.
5. Contractor shall train cables to the termination points with no excess where cable is installed within enclosures.
6. The contractor shall not install any cable in conduits that does not have the appropriate protect bushings on conduit ends. All mis-installed cable will be removed, bushings installed, and new cable re-installed at the Contractor’s expense. No additional cost will be submitted to Owner.
7. Do not install bruised, kinked, scored, deformed, or abraded cable. Remove and discard cable if damaged during installation and replace it with new cable.
8. Do not splice cable between termination, tap, junction points, or between damaged cable segments.
9. Any exposed cables shall be installed parallel to building lines. Follow surface contours and support the cable according to manufacturer's written instructions. Do not run adjacent and parallel to power or data cables. All exposed cable routing shall be coordinated with the Owner and Owner’s Representative prior to installation.
10. Care shall be taken so as not to damage cable during the installation process and that the manufacturer’s and industry standard’s pull tension specification is not exceeded.
11. Within communications rooms, cables shall be snugly wrapped using Velcro reusable cable ties, a minimum of every 3’-0” for cable organization. Velcro ties shall be tightened so as not to deform cable jackets and thus affect cable performance. Plastic cable tie wraps shall not be used.
12. Provide independent signal circuit grounding recommended by manufacturer.
13. Under no circumstances shall the cable be painted, treated, or covered with other material unless approved by manufacturer.

D. Cable Testing RL and DTF: The following procedures shall apply to cable testing:

1. Contractor’s technicians must be fully certified by the Cable and Antenna Analyzer Test Equipment vendor to perform the test and provide the test results. Contractor shall provide copies of RL test certifications with their submittals.
2. Calibration must be performed to manufactures specification.
3. RL and DTF testing must be performed on a cable and antenna analyzer that meets or exceeds a Site Master S332E.
4. All coax cables shall be segment tested to show RL and DTF.
5. Each system shall have a system RL test performed.
6. Each test shall be performed with the following frequency bands.
    a) Public Safety Band: 700-900 MHz with marker to peak.
7. RL limit line must be set to 20db when segment testing.
8. DTF limit line must be set to 25db (unless otherwise stipulated by manufacturer) with a cable length 20% longer than expected.
9. System RL limit line must be set to the antenna VSWR/RL spec.
10. Cable segment and system tests shall be recorded as Pass/Fail in an Excel

report of the test data recorded and saved. The report shall identify.

a. The frequency(s) of the test
b. The date/time of the test
c. The technician performing the test
d. The site name
e. The cable ID
f. The recorded RL or DTF value
g. Pass/Fail Indication
h. The Test Equipment Vendor and Model, Serial Number, Last Calibration Date, and Software version.

11. All segment and system RL and DTF sweeps shall be recorded in PDF format and provided along with the Excel report. These test results must be submitted before site commissioning can take place.

E. Isolation Testing: The following procedures shall apply to isolation testing:

1. Contractor's technicians must be fully certified by the Spectrum Analyzer Test Equipment vendor to perform the test and provide the test results. Contractor shall provide copies of certifications with their submittals.
2. Calibration must be performed to manufactures specification.
3. Isolation testing must be performed on a spectrum analyzer that meets or exceeds a Site Master S332E.
4. Isolation testing must be performed using a CW generator capable of generating the frequencies of the ERCES.
5. Isolation testing must be performed on both the DL and UL on all frequencies of the system.
6. Isolation must measure 20db higher than the gain settings of the BDA.
7. All isolation tests shall be recorded in PDF format. These test results must be submitted before site commissioning can be performed. A physical copy shall also be left with the BDA.

F. Antenna Installation: The following procedures shall apply to antenna installation:

1. All antennas and associated locations shall be discreet. Antennas shall be concealed wherever possible using stealth technology to ensure installation maintains high architectural form critical to the high-end finish of this project.
2. All antenna locations shall be coordinated with Owner's Representative prior to initiating any work.
3. Install antennas per manufacturer's requirements.
4. Contractor shall install antennas with all necessary supports to ensure safe installation and support to prevent falling.
5. Antennas shall be rated accordingly and as applicable for the installation type, location, condition, and application supported.
6. Placement of donor antennas shall be coordinated with general contractor and owner group. Antenna placement must meet RX signal and isolation requirements for the system to function properly.

G. Equipment Installation: The following procedures shall apply to equipment installation:

1. Install tamper proof receptacle cover where annunciator is powered
2. Arrange equipment to facilitate access for maintenance and to preserve headroom and passage space.
3. Label all equipment and interfaces.

3.3 COORDINATION

A. Design Coordination: All components proposed by the Contractor shall be coordinated with the Owner and Project team. Provided below is a general list of major items that shall be documented in a table and coordinated. The list provided below is to be used as an example and is not intended to be all inclusive or to limit items required to be reviewed and coordinated.

1. Equipment Type and Physical Size.
2. Rack Units required per location.
3. Electrical Power (voltage, amp, loads, and receptacle types)
4. HVAC (heat dissipation and equipment operating temperature range)
5. Antenna Types and Locations
6. Backbone Distribution (fiber strand allocation)

B. RF Coordination:

1. The Contractor shall perform an onsite RF study prior to starting work. This information shall be submitted in hard copy documents.
2. The Contractor shall obtain a copy of the Owner's current RF strategy and frequency assignment (if available, provide new where none exists). This information shall be reviewed in detail to identify any interfering and/or potentially interfering sources.
3. The Contractor shall review and coordinate the onsite study, Owner's current RF strategy and frequency assignment (if available, propose new if there is none), and ERCES design. The Contractor shall make recommendations to the Owner and adjust the proposed design accordingly to ensure no interfering sources or overlap of frequency assignment.
4. The Contractor shall perform an on-site RF study after completing system installation. This information shall be submitted in hard copy documents. The results of this test shall be reviewed by the Contractor and Manufacturer to confirm system compliance with coverage, and performance requirements.
5. All documents submitted by Contractor including product data, submittals, as-built, test results, drawings, reports, etc. shall be provided in electronic (pdf) and paper format.
6. The Contractor will coordinate all Public Safety frequencies, preferred manufacturer make/model, antennas, equipment, power conditions and locations.
7. Refer to submittal requirements as outlined in Section 1.4.

C. Installation Coordination: The Contractor shall field coordinate all work with

Construction Manager and other Sub-Contractors and Trades as necessary to minimize conflicts.

D. Schedule: The Contractor shall coordinate the project schedule with the Construction Manager including but not limited to the following:

1. RFP Response
2. Submittals
3. Construction and Phasing
4. Installation
5. Substantial Completion
6. Final Completion
7. System Acceptance

3.4 IDENTIFICATION

A. The following procedures shall apply to system labeling:

B. General Label Requirements:

1. The labeling scheme shall be provided by the Contractor and coordinated with the Owner and Owner's Representative prior to initiating any work. A sample scheme shall be submitted for approval.
2. Mechanically print and install all labels.
3. Format: Select font size to be readable and to fit all information required without overlap of text.
4. Use all capital letters.
5. All labels shall be consistent font type, size, and color throughout project.
6. Labels shall be white with black text.
7. Clean all surfaces prior to attachment of any label. Follow manufacturer's recommendations for cleaning and affixing labels.
8. Method: Brady cable labels appropriately sized or approved equivalent.

C. Cable:

1. Label Location: Within 4 inches (100 mm) of each termination.
2. Near-End Label Information: "Cable No. XXX and Comm Room ZZZ -DAS Cable. Do not disturb," where XXX and ZZZ are actual room numbers assigned. Room numbers shall be coordinated with Owner and Owner's Representative.
3. Far-End Label Information: "Cable No. XXX and Room ZZZ -DAS Cable. Do not disturb," where XXX and ZZZ are actual room numbers assigned. Room numbers shall be coordinated with Owner and Owner's Representative.

D. Equipment:

1. Label all equipment, components, cabinets, and enclosures.
2. Label Information: Equipment No. and Type (or Short Description).

3.5 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Contractor shall engage a designated representative to inspect field-assembled components and equipment installation, and supervise pre-testing, testing, and adjusting of equipment.

B. Inspection: Contractor shall verify that units and controls are properly installed, connected, and labeled and that interconnecting wires and terminals are identified.

C. Pre-testing: Contractor shall align and adjust system and pretest components, wiring, and functions to verify that they comply with specified requirements. Replace malfunctioning or damaged items. Retest until satisfactory performance and conditions are achieved.

D. Operational Tests: Contractor shall perform operational system tests to verify that system complies with Specifications. Operational tests shall include all modes of system operation. Equipment shall be tested for proper operation in all functional modes.

E. Qualitative and Quantitative Performance Tests: Contractor shall verify for channels identified by Owner that signal coverage area, signal coverage levels, and signal coverage consistency are compliant with Specifications. Testing shall be conducted using calibrated "walk- test" receivers in a grid test pattern dividing the floor equally in twenty grid squares

F. Test Results: Contractor shall record test results and publish them in electronic version for distribution to the local AHJ and Owner.

G. Final Inspection: Contractor will accompany an assigned ASU agent for system testing & onsite inspection. Contractor will accompany RWC/TRWC for system testing. Owner & Licensee approvals are required for final sign off.

H. Re-Test: Contractor shall correct all deficiencies identified by tests and observations, and retest until specified requirements are met.

I. Commissioning:

1. Contractor shall create and submit a detailed checklist for commissioning system equipment and components. The list shall be submitted for Owner review. System commissioning shall be completed by the Contractor prior to system acceptance by Owner. A formal report shall be generated that includes sign-off and notes of all items.
2. System commission shall include the following categories.
   a. Validate Procured Components
   b. Physical Installation and Location
   c. Equipment Connectivity and Inter-Connectivity
   d. System Setup and Operation
   e. Wireless Surveys
   f. Testing

3.6 CLEANING

A. Contractor shall clean installed items using methods and materials recommended by manufacturer.

B. Contractor shall clean system components, including antennas and supports, electronic equipment, and distribution components.

3.7 RECORD DOCUMENTATION

A. Record documentation shall be submitted to the Owner by the Contractor at the completion of the DAS installation. The contractor shall submit all information necessary to operate and maintain the system including but not limited to the following:

1. As-Built Documents
2. Operations and Maintenance Manuals
3. Product Data and Manufacturer Cut-Sheets (including serial number)
4. Warranty Information and Contact
5. Manufacturer's Product and Installation Certificate
6. Labeling Scheme
7. Final Grid Report
8. System Screen Shots
9. Coaxial tests (Cable Sweeps)
10. Fiber tests (OTDR)
11. Installation Photos
12. System Registration

B. Contractor shall maintain current record documents at the construction site.
C. All documents submitted by Contractor including product data, submittals, as-built, test results, drawings, reports, etc. shall be provided in electronic (pdf) format.
D. Refer to submittal requirements as outlined in Section 1.4.

DIVISION 28 – ELECTRONIC SAFETY AND SECURITY

28 10 00 – Security Access and Surveillance

Description

This section applies to all ASU-owned, occupied and (where applicable) leased property. All physical security design and selection will adhere to the standards, specifications and approval processes as presented in the multiple sections of this document and specifically outlined in DIVISION 8 and DIVISION 28 (this section).

During the initial phases of the project (during Design Development [DD]), Preparedness and Security Initiatives staff in cooperation with other appropriate ASU entities should provide guidance on all physical security needs of the project.
Discussion shall include the project specific system, maintenance and service responsibilities of the system, and applicable annual projected funding needs. This standard applies to door access, alarms and video security systems. All buildings shall include an electronic door access system at appropriate entries from the exterior, and for all laboratories as well as high risk or highly valued human or physical assets require security as a minimum.

1. ISAAC is the Integrated Security for ASU Access Control based on the Lenel OnGuardPro software and other approved systems that integrate into ISAAC. Current RFP award 161501 specifies the approved contracted vendor to install ISAAC as the standard for all related Security and Door Access systems.
2. Door access shall mean any and all electronic means of door control not relying on a mechanical key and/or solely mechanic hardware.

3. Alarm shall mean any intrusion or duress equipment (non-fire/building control) used for reporting and/notification to create an immediate response from an agency associated with situational awareness, incident management, and protection either in part or for protection from law enforcement entities.
    a. Alarm supervision is a part of RFP 161501 for remote third party monitoring and dispatch as ASU's standard provider for such services.
4. GENETEC video security shall mean video equipment used for storage or live transmission of video used for risk mitigation, liability mitigation, and/or protection. Video may be used solely for forensic analysis, used for live surveillance when approved, and used in business intelligence analytics when approved within the proper ASU data security standards.

Exceptions for any electronic safety and security system implementation in a new or remodel situation outside of that specified within these guidelines and as a part of the ISAAC program shall be due only to the following and shall not include exceptions due to monetary constraints.

All exceptions shall be approved by the Preparedness and Security Initiatives team along with other appropriate ASU entities. Some exceptions may include:

- Federal Regulatory compliance which requires isolated and non-integrated systems.
- Acquisition of property where there is a security system in place and the determination is such that any new construction or remodel is deemed to have a substantial reason to remain on the legacy system.
- Other space where it is deemed and approved via processes described in these guidelines to have a need to maintain isolation.

Security access control shall not be considered as a system to accommodate time and attendance tracking and/or membership tracking but may be used for business intelligence under controlled situations.

Programming and Design

A. ISAAC shall be used to control access at all exterior doors and at certain interior access control zones, such as specialty labs, computer labs, some office suites, some audio/visual equipment rooms, and other areas with specific access concerns as well as used for alarms minimum standards are defined by Preparedness and Security Initiatives staff and applies to all new buildings and remodels.

B. To facilitate the implementation of ASU access control system (ISAAC), certain programming issues should be considered during programming and design. These include:
    1. Evaluation of the need for emergency power.
    2. Physical separation between public/non-public areas.
    3. Physical separation between different departments/operating units in the same building.
    4. Access during periods of time on weekends and after hours.
    5. Conflicts between access control and life safety, i.e., egress, latching of fire doors, and other safety considerations.
    6. Conflicts between access control and ADA accessibility.
    7. Minimum levels of security to be afforded to Laboratories and high risk or high value areas.
    8. Door Access to public bathrooms.

9. ET and FACMAN areas of concern such as equipment rooms, IDF/MDF, and data centers.
10. Distance, environment, and specific applicability and treatment.
11. Power and communication protocols and compensating controls around encryption and secure protocols as well as bandwidth needs for video.
12. Video security placement, distance, infrastructure and lighting.
    a. At a minimum video should be placed on exterior doors, stairwells, MDF/IDF, and on all newly placed emergency call box locations.
    b. Signage is required in locations where video security is present.
13. Video storage requirements dependent on the video specifics and needs.
14. Forensic or immediate needs for reporting and/or signaling and notifications.
15. Maintenance, administration and support as well as ongoing funding requirements.
16. Other specifications of openings, finishing, and equipment specified in DIVISION 8

Design Standards

A. In the design phase, the DP should assess, with the participation of ASU Preparedness and Security Initiatives and other appropriate ASU entities needs regarding security and the possible extent and type of that security. The program budget should reflect these as a minimum. Intrusion systems shall be programmed into areas of high risk, low visibility such as tunnel access points, roof access points, storage facilities of deemed asset value or research value, financial transaction processing centers, or any other areas deemed high risk during design.
   1. At a minimum ISAAC system shall be programmed into all exterior building entrances, areas of high risk, high visibility/prestige such as executive offices of the president's/provost's staff and general counsel, health and well-being centers, financial transaction processing centers, and any other areas deemed high risk during design.

B. Equipment used for security shall never be co-located in the communication/network rooms unless approved as an exception. Hardware used for security needs to be located in secure rooms with limited access and that does not include janitorial access.

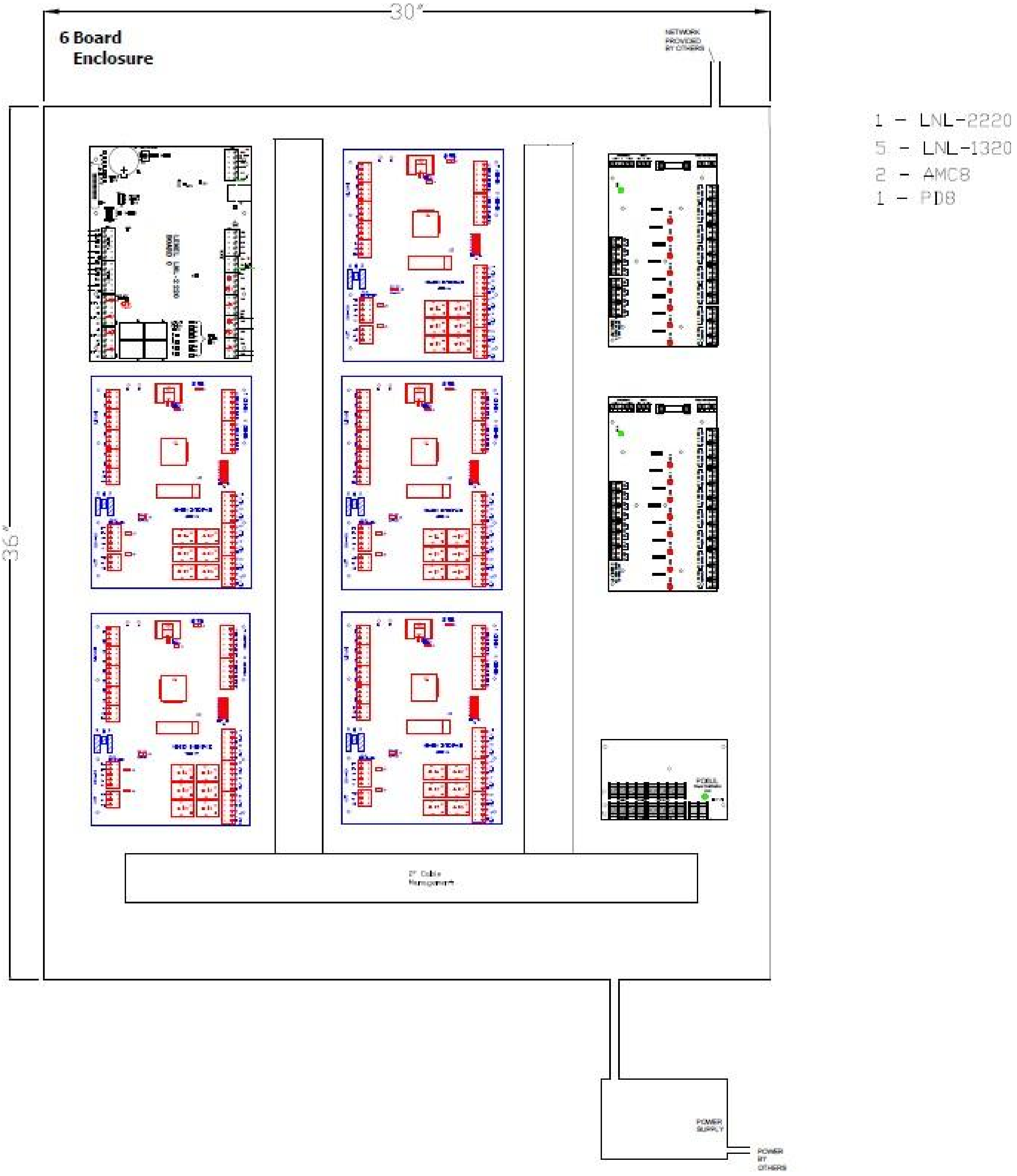
C. ISAAC Systems Architecture Typical

D. Building Equipment/Hardware Environment
   1. Private VLANs connect the ISAAC hardware (Intelligent System Controllers, NVR's, IP cameras) to the secure server room.
      a. DVRs (Digital Video Recorders) are not approved.
   2. There is at least one Intelligent System Controller (ISC) in each building connected to the ISAAC VLAN. The edge devices such as card readers, contacts, alarm panels and other security equipment are connected to the ISC's – up to 64 devices per ISC may be accommodated.
      a. The number of ISC's in a building is dependent on programming and design requirements.
      b. ISC's are often referred to as "Head End(s)".
      c. A single Head End enclosure is 30 x 36 inches with a door opening of 30 inches.
         i. Enough room is needed for the door swing of 36 inches plus standing room. A four foot allocation in front of the enclosure is adequate.

            - ii. A typical 30 x 36 enclosure can handle approximately 20 – 24 devices.
        - d. A Head End is typically located in a secure closet in the building but may not be located in the same location where telecommunication and network devices are installed.
        - e. Each Segment in a building needs its own ISC.
        - f. A Segment is dependent on the occupants and intended use of the areas in the building and typically decided during the design phase with ISAAC and Transaction Services assistance.
        - g. One Ethernet connection on the ISAAC VLAN is required for each ISC.
        - h. An ISC can support up to 64 single or 32 dual reader interfaces.

3. Devices connected to the ISC box are:
    - a. 24V Power Supply (PS) with 2-12V battery backup are connected to 120V AC.
    - b. Doors with electric locks, electric strike, magnetic lock or electrified panic bar. Each door has a junction box or local power supply connected to it and which 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 gauge/6 conductor), 1- 18/4, 2-22/4.
    - c. 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 or low voltage kit. The door with the electric lock also shows a door position sensor (DPS) at the top that is wired to the junction box.
    - d. The doors with the electric strike and the magnetic lock have request to exit (REX) over the door.
    - e. At least one power supply and reader interface location is required per floor.
    - f. Equipment locations require 120 VAC connections.
    - g. Door with electrified panic hardware require a local power supply with a 120 VAC connection. Battery backup is optional.
    - h. All other lock hardware is powered by a 24 VDC located in the equipment locations with battery backup.
    - i. There is one pair data line between the ISC and the equipment on each floor.

Typical Head End



E. Secure Closet Space

1. There shall be at least one dedicated closet for the location of ISAAC related equipment. In multi-story buildings where ISAAC equipment is located above grade, there shall be a closet on each floor if the floor contains controlled doors.

   a. The secure closet shall not be an ISAAC panel shall not be installed in an IDF or MDF closet unless approved by ET. ISAAC Panels are not to be installed in high voltage mechanical rooms.

2. Identify and reserve an area of about 7 feet wide, and 4 feet deep floor to ceiling in a communications closet on each floor. Mount ¾ inch plywood as backing board, if it is not already there. Allow a 4-foot clearance in front of the identified area for door swing.
3. 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.
4. 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.

F. 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.

G. Cabling Installation

1. All cabling shall be plenum and UL listed.
2. All wall and floor penetrations shall be sleeved and fire stopped.
3. All cabling shall be self-supported with J-Hooks either from the wall or with self-supported hanger wire.
4. All vertical and horizontal pathways shall be 12 inches away from any voice/data cabling.
5. Existing voice/data pathways will not be utilized for security door cabling.
6. If the system controller is installed within a telecommunication room, the space will be pre- approved with ASU Information Technology.
7. The system controller location(s) will be denoted on the floor plan and will be mounted in a locked cabinet.
8. The ASU Ethernet connection or connections required for the individual security system will be denoted on the floor plans.

H. 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. ASU follows all ADA requirements for accessibility.

1. ISAAC Database and Segments
    a. Software Standard: LENEL Software shall be "PRO" level standard.
    b. Hardware Standard: HID iClass Smart Card and Smart Card Readers. All interfaces will have to be compatible with the latest iCLASS CATALOG on file with the university.
    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.
        i. **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.

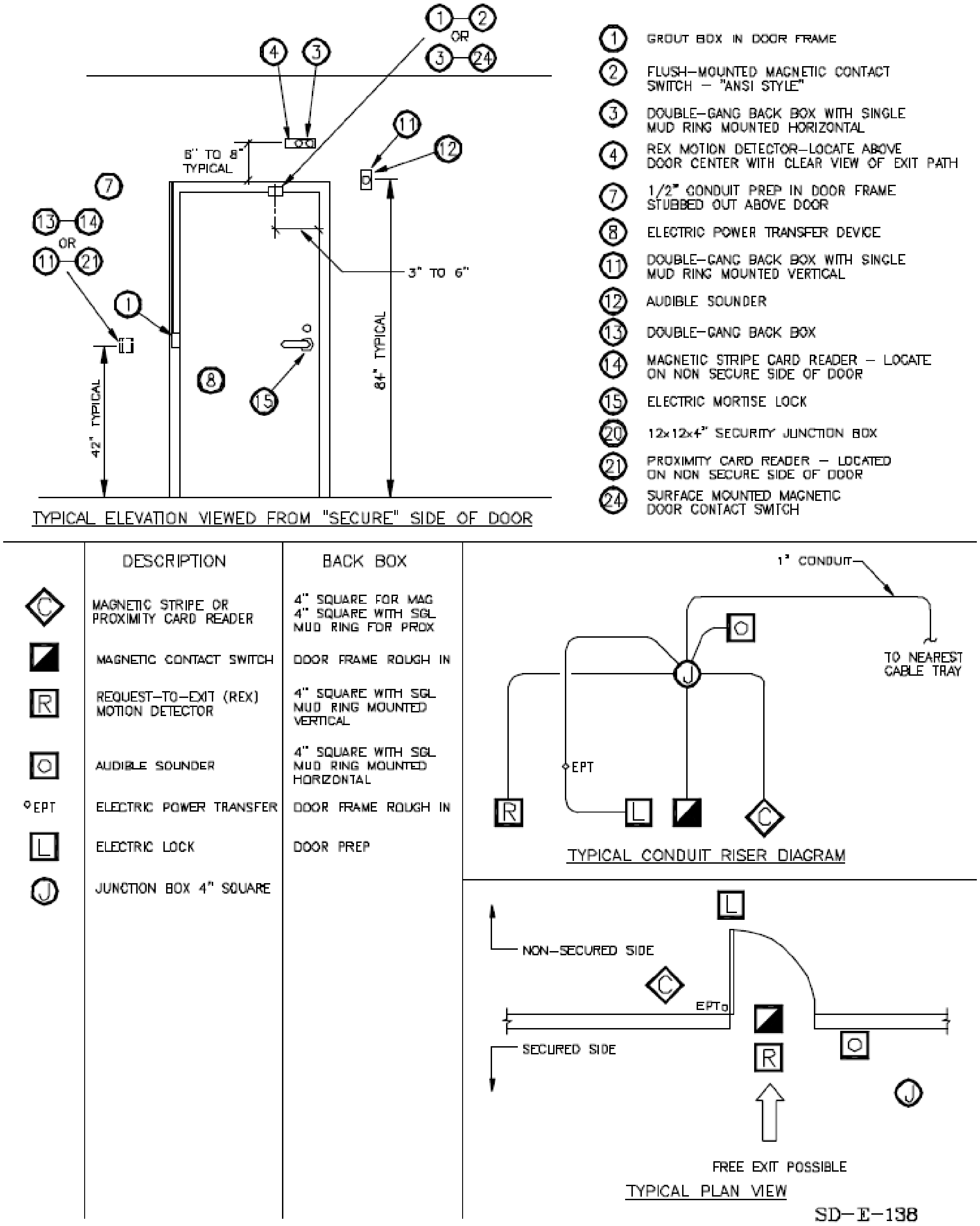
e. Reader interface units cannot be split among segments, so readers that are physically connected (wired) to a particular reader interface unit must be all in the same segment. This might occasionally mean that there is a need to install more reader interface units than would be required in a non-segmented database, or to require a reader from one reader interface unit to another when responsibilities change.

2. ISAAC Installation Planning – The ISAAC Systems Administrator 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 maximize efficiency with the installation of ISAAC access control system. However, it is still best to coordinate projects with the Preparedness and Security Initiatives team and the contracted vendor representing the ISAAC system from the design stage.

   a. Alarm panels are connected to the central ISAAC system on the secure VLAN as well as have the ability to connect to analog phone lines to dial to a centralized monitoring center. The intrusion and duress alarms provide immediate notification as well as reporting and situational awareness for the safety and security of the ASU community where they are specifically deployed. ISAAC and Transaction Services will assess each situation and applicability to assist the design and programming needs for intrusion and duress and prepare appropriate configurations and determine storage and ongoing funding requirements.

Diagrams:

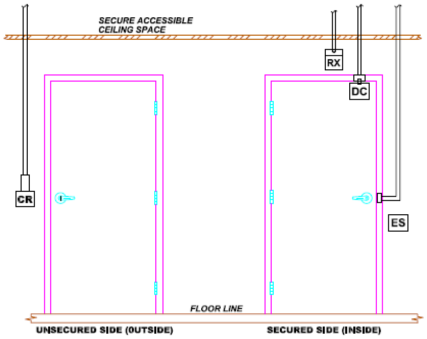
A. Typical Lock Installation of Door – THIS IS ONLY AN EXAMPLE



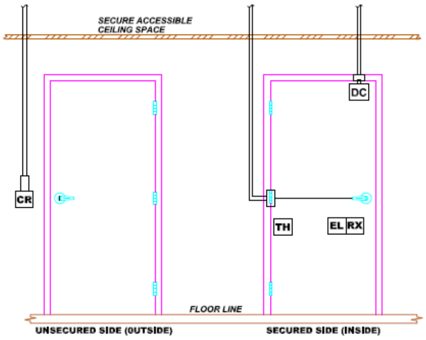
① GROUT BOX IN DOOR FRAME
② FLUSH-MOUNTED MAGNETIC CONTACT SWITCH – "ANSI STYLE"
③ DOUBLE-GANG BACK BOX WITH SINGLE MUD RING MOUNTED HORIZONTAL
④ REX MOTION DETECTOR-LOCATE ABOVE DOOR CENTER WITH CLEAR VIEW OF EXIT PATH
⑦ 1/2" CONDUIT PREP IN DOOR FRAME STUBBED OUT ABOVE DOOR
⑧ ELECTRIC POWER TRANSFER DEVICE
⑪ DOUBLE-GANG BACK BOX WITH SINGLE MUD RING MOUNTED VERTICAL
⑫ AUDIBLE SOUNDER
⑬ DOUBLE-GANG BACK BOX
⑭ MAGNETIC STRIPE CARD READER – LOCATE ON NON SECURE SIDE OF DOOR
⑮ ELECTRIC MORTISE LOCK
⑳ 12x12x4" SECURITY JUNCTION BOX
㉑ PROXIMITY CARD READER – LOCATED ON NON SECURE SIDE OF DOOR
㉔ SURFACE MOUNTED MAGNETIC DOOR CONTACT SWITCH

	DESCRIPTION	BACK BOX
◇C	MAGNETIC STRIPE OR PROXIMITY CARD READER	4" SQUARE FOR MAG 4" SQUARE WITH SGL MUD RING FOR PROX
◩	MAGNETIC CONTACT SWITCH	DOOR FRAME ROUGH IN
R	REQUEST-TO-EXIT (REX) MOTION DETECTOR	4" SQUARE WITH SGL MUD RING MOUNTED VERTICAL
O	AUDIBLE SOUNDER	4" SQUARE WITH SGL MUD RING MOUNTED HORIZONTAL
∘EPT	ELECTRIC POWER TRANSFER	DOOR FRAME ROUGH IN
L	ELECTRIC LOCK	DOOR PREP
J	JUNCTION BOX 4" SQUARE	

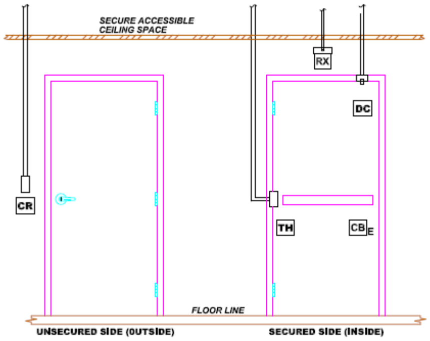
Typical Card Reader Controlled Single Door



CARD READER - DOOR CONTACT - ELECTRIC STRIKE - REQUEST TO EXIT



CARD READER - DOOR CONTACT - ELECTRIFIED LEVER WITH REQUEST TO EXIT - POWER TRANSFER HINGE



CARD READER - DOOR CONTACT - TRANSFER HINGE - ELECTRIFIED CRASH BAR - REQUEST TO EXIT

28 30 00 – Fire Alarm System Codes and Standards

1.1 General

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**)

For the purposes of this document (Section 28 – Fire Alarm System Codes and Standards), all references to “AHJ” shall be the Fire Code Official having jurisdiction over the project site.

1.1.4 ASU Required Vendor

Per RFP #171201 the fire alarm system shall be furnished and installed by awarded contractor **OR** as accepted by AHJ **AND** ASU’s Fire Systems and Support Technologies Supervisor, when applicable.

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, Capital Programs Management Group, and AHJ 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 stamped drawings to the Owner**.

1.2.2 ASU Fire Systems and Support Technologies

Any alteration to existing fire alarm systems shall be verified, in writing, by the ASU Fire Systems shop supervision and/or Fire Marshal’s office before the start of work.

1.2.3 Codes - Fire

The equipment and installation shall comply with the current minimum provisions or as otherwise stated as the most stringent of the following codes and standards:

- NFPA 70 - National Electric Code®
- NFPA 72 - National Fire Alarm Code® 2016 Edition
- NFPA 90A - Air Conditioning Systems
- UL 864 - Control Units for Fire Protective Signaling Systems.
- UL 268 - Smoke Detectors for Fire Protective Signaling Systems.
- UL 268A - Smoke Detectors for Duct Applications.
- UL 521 - Heat Detectors for Fire Protective Signaling Systems.
- 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.
- IFC adopted by the State of Arizona 2018 Edition
- Americans with Disabilities Act (ADA)
- ASU Fire Alarm Systems and Design Standards
- ASUPD, ASU Fire Marshall and EHandS Design Standards for Mass Communication
- ASUPD, ASU Fire Marshall and EHandS Design Standards for Radio Communication
- ASUPD, ASU Fire Marshall and EHandS Design Standards for overall detection and evacuation (i.e. Manual Pulls, etc.)

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 respect 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 will 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. Drawings need to be submitted as both a PDF and a DWG file, unless otherwise specified by the ASU CAD department.
- 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 NFPA 72.
- Copies of panel and system programs delivered on a flash drive to ASU’s Fire Systems and Support Technologies group.

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 drawings, unless directed otherwise by AHJ. In addition, one manual pull station shall always be installed next to the FACP unless one already exists.
- Area smoke detection shall be provided as shown on drawings, unless directed otherwise by AHJ.
- Area heat detection shall be provided as shown on drawings, unless directed otherwise by AHJ.
- Beam smoke detection shall be located as shown on drawings, unless directed otherwise by AHJ.
- Duct smoke detection shall be provided as shown on drawings, unless directed otherwise by AHJ, and provide individual fan shutdown controls as shown on drawings, unless directed otherwise by AHJ. Each damper and/or AHU shall have a separate addressable relay for means of shutdown. Shutdown of a 120V circuit controlling multiple dampers or AHU's is unacceptable.
- Provide audible appliances located throughout the building, as shown on drawings, unless directed otherwise by AHJ, and provide synchronized visual appliances located throughout the building, as shown on drawings, unless directed otherwise by AHJ. Speaker and/or horn strobes shall be installed in any mechanical room were mechanical devices, such as pumps, provide high levels of noise.
- Smokes shall be installed in all corridors and paths of egress.
- Pull stations shall be installed at any exterior exit point of a building unless otherwise stated by the AHJ.
- Provide supervised individual address monitoring of sprinkler tamper and waterflow devices as shown on drawings, unless directed otherwise by AHJ.
- Provide primary and alternate elevator recall with the ability to auto-reset elevator upon FACP reset.
- Elevator controls shall be on a SIGA-UIO6R with MCR’s and MCT2’s.
- Provide a primary and secondary means of communication for the FACP
- Primary shall consist of a fiber optic connection to the campus ASU Fire Systems fiber optic network. The Contractor shall be responsible for bringing in the new fiber from fiber hubs identified by ASU Fire Systems and Support Technologies and landing and terminating the fiber in LIU’s next to the FACP. The Contractor shall be responsible for conduit from the Network FACP, to the LIU, thru to the nearest active network connection.
    - Secondary shall consist of 2 data drops on the Building Controls FIRE VLAN – part of the ET network.
    - If NO data connections are available, primary and secondary communications shall consist of the use of two analog phone lines.

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 water flow 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 and visual devices throughout the building.

- Transmit alarm signal to ASU designated monitoring with point identification.
- First Smoke Detector notification will be labeled as an Alarm condition and display that Alarm notification through our Central Station, but not Audibly and Visually activate throughout the Structure, second Smoke Detector (initiation device) will Audibly and Visually activate throughout the structure.
- High-Rise Structures shall be set to activate at the initiated floor and one floor above and two floors below the initiated floor level.

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 unless part of an approved smoke control system.

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 display shall indicate all applicable information associated with the trouble condition including; address, device type, device location and time/date.
- Transmit signal to the campus alternate monitoring site with point identification. ASUPD shall not receive Trouble alarms.
- Any trouble conditions received by the FACP will not be forwarded to the FAAP. The FAAP will only display Alarm and Supervisory conditions within the building.

ASU - FIRE ALARM SEQUENCE OF OPERATIONS MATRIX

First Issue: 24 August 2005
Approved: 6 September 2005

	Initiate Audible and Visible Alarm Signal at FACP	Initiate Audible and Visible Alarm Signal at Annunciator	Initiate Audible and Visible Supervisory Signal FACP	Initiate Audible and Visible Supervisory Signal at Annunciator	Send Status Charge to Campus Network System	Activate All Horns and Strobes	Shut Down Affected Air Handler Unit	Close Associated Smoke Damper	Recall Elevator to Designated Floor	Shunt Trip Elevator Controller	Close Associated Fire Doors
Pull Station	X	X			X	X					
Sprinkler - All types - Also Includes other suppression systems such as Halon, FM200 and hood systems											
Water Flow/Activation	X	X			X	X					
Tamper/System Trouble			X	X	X						
Smoke Detector	X	X			X	X					X
First Duct Smoke Detector in Alarm Condition			X	X	X		X				
Second Duct Detector in Alarm Condition			X	X	X		X				

First Duct Type Smoke Detector for SFD operation in Alarm Condition			X	X	X			X			
Second Duct Type Smoke Detector for SFD operation in Alarm Condition			X	X	X			X			
Area Detector Used for SFD operation	X	X			X	X		X			
Heat Detector	X	X			X	X					
Elevator Lobby Smoke Detector	X	X			X	X			X		
Elevator Equipment Room Smoke Detector	X	X			X	X			X		
Elevator Shaft Smoke Detector	X	X			X	X			X		
Elevator Equipment Room Heat Detector	X	X			X	X				X	
Elevator Shaft Heat Detector	X	X			X	X				X	

This Sequence of Operations Matrix is intended to be a standard for ASU buildings such as classrooms, offices, 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.

Secondary Power Supply

Standby power supply shall be an electrical battery with capacity to operate the system under maximum supervisory load for **twenty-four (24) 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

1.3.4.2 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 manual by-pass switches for the following:

- AHU Shutdown by-pass
- Elevator Recall/Shunt Trip by-pass
- A/V by-pass
- Magnetic Door Holder circuit by-pass
- Smoke Damper by-pass

1.3.4.3 Initiating Device Circuits

Initiating device circuits monitoring manual fire alarm stations, smoke and heat detectors, shall be Class A, and will use #16 AWG yellow jacketed (unshielded)/STP/FPL solid copper wiring and shall be installed in a red EMT conduit, and a min 2 1/8” deep 4 square boxes. The installation of the conduit shall use compression fittings.

1.3.4.4 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 red EMT conduit, and a min 2 1/8” deep 4 square boxes. The installation of the conduit shall use compression fittings. All notification appliance circuits shall have a minimum circuit output rating of: 2 amps @ 24 vdc. The notification circuits shall be power limited. For major remodels/ renovations and for changes to “A” occupancy, if an AHJ variance is issued for a system without voice annunciation, the contractor shall install a spare #16 AWG white jacketed STP for future voice addition. This wire shall be installed as one loop per floor and as a homerun back to the main FACP.

1.3.4.5 Signaling Line Circuits

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.

1.3.4.6 Network Wiring

- There shall be an ASU requirement for the fire alarm system to provide redundant communications to the ASU Police Communications Fireworks monitoring center.
- Fire Networking Physical Requirements –EST4 Fire Panels
- Two communication paths are required for all fire alarm systems.
- On the Tempe Campus, connection to ASU’s Dedicated Fire Fiber Network for Primary System monitoring is required, with a Fire VLAN connection to be used as the secondary communication path.
- On other campuses, or at locations with no Dedicated Fire Fiber Network available, one Fire VLAN connection, and one dual phone line telephone connection are required.
- Capability of primary and backup reporting to Fireworks server/s at ASUPD.
- Each FACP will have 2 forms (Primary and Secondary) of independent communications to the ASUPD Fireworks server/s with event type identification. ASU Fire Systems and Support Technologies must be consulted in coordinating which type of communications will be acceptable.
- Primary communications on the Tempe Campus shall consist of interconnecting to the dedicated ASU Fire System Fiber network using the protocol TCP/IP.

- The media shall be a Commscope 24-strand Single-Mode, Armored, Outdoor Rated. (Plenum, riser fiber transition, as required, at building entry depending on environment).
- Secondary communications shall consist of 2 data drops on the Building Controls FIRE VLAN.
- If neither form of communications is available, the use of an analog phone lines will be acceptable.
- At this time, the requirement for primary Fiber communications is only for the Tempe campus. Downtown, West and Poly all require a FIRE VLAN connection and two telephone lines for communication until a Fiber infrastructure has been established
- When one form of communication has been lost, the second form must take over and transmit the signal.
- The loss of any form of communication must also trigger an alert at each monitoring system and send a corresponding Email.

- All fiber terminations shall be LC, fiber terminations must be terminated at an LIU.
- The use of Single-Mode fiber cable may require single mode to multimode converters connecting to current legacy systems.
- New controls interface devices will be supplied with an appropriate Single-Mode SFP transceiver, LC interface.
- Patch cables shall be installed by the contractor.

- All Fire Fiber shall be installed in RED Inner-Duct where visible. OSP innerduct is acceptable for outside of building runs while plenum/riser innerduct is required for all in-building installations.
- Fiber patch cable from LIU to FACP shall be in ¾" conduit.
- Fiber patch cable from LIU to Fire Fiber Switch shall be in ¾" conduit.

- Fiber shall connect from Fire Panel HEAD END via a "home-run" to closest Fire Fiber network switch.
- Current Tempe locations include but not limited to:

- Business Admin C wing
- Bulldog Hall
- SHESC - Anthropology
- Desert Financial Arena
- Central Plant
- Physical Science E Wing
- Life Science A Wing
- ISTB 2
- South Central Plant
- Weatherup Basketball Practice Facility
- Palo Verde East

- All panel-to-panel connections within a building shall be CLASS A..
- IF the FIRE fiber network is unavailable, one Fire VLAN connection, and two analog POTS (telephone) lines shall be installed at the head end panel.

- Two FIRE VLAN drops need to be installed at each Fire Panel:
- DROP#1: ASUPD Fireworks Server/s
- DROP#2: Technician Diagnostic Port
- A supervised method shall be provided to disable the communications that report from the alarm system (FACP) to the ASU Police Communications Center during regularly scheduled testing or maintenance to reduce nuisance alarms to ASU PD.

1.3.4.7 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 not purchase any equipment for the system specified herein until the owner, AHJ, Fire Systems Supervisor and engineer have 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 stamped by PE (Fire and/or Electrical) or NICET IV signature. Any drawings requiring additional power need to have been calculated and stamped by an Electrical PE.

Prior to submission a courtesy plan review with device locations is recommended to be completed with ASU FACMAN and ASU Fire Marshal. A courtesy plan review may eliminate many issues and problems that may arise during the actual plan review.

All devices on floor plans shall match the SLC and NAC risers on a point for point basis in order of wiring. Each SLC device address and NAC device number shall be unique and the wiring/numbering layout on the floor plans shall match the system riser. Each SLC device shall be labeled with its 8 digit device address. This label shall be a ½” in height, white label with black lettering.

Smoke detection in Path of Egress which is defined as any space where a person exiting a room would pass through to exit the building.

Monitoring Modules for Fire Sprinkler devices will be mounted equal height or higher than the device.

Fire Alarm System Plans shall be submitted to the ASU FMO for review prior to beginning any on site construction or installation work.

All new system installations or modifications to existing fire alarm systems shall for reporting purposes include the system being tied into the Fireworks Monitoring system for reporting and the ASU PD communication center.

1.4.1.1 Requirements for EHS Fire Safety and Prevention Construction Permit

1. Adding, replacing or upgrading 6 or more devices.
2. Adding, replacing or upgrading the FACP, FAAP and/or NACPS.
3. Adding, replacing or upgrading any fire alarm device connected to the HVAC system.
4. All submittals shall be deferred and any reference to life safety devices in the construction documents shall be viewed as conceptual only.

These documents shall be submitted for review and permitting to EHS Fire Safety and Prevention office.

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 AHJ, ASU FSST and the Engineer of record.

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 PE (Fire and/or Electrical) or 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

Must meet the requirements of RFP #171201

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 and/or an AHJ approved certification, such as the City of Phoenix CSA certification.

1.4.4.2 System Battery Calculations

Complete calculations shall be provided which show the electrical load on the following system components:

- Each system power supply, including standalone booster supplies.
- Each standby power supply (batteries).
- Each notification appliance and initiating circuit.
- Each auxiliary control circuit that draws power from any system power supply.
- All circuits are to be calculated at a 60 hour standby and with a 15 minute active alarm.
- All calculations need to be stamped by an Electrical and/or Fire PE or NICET IV.

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 closeout 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 DWG and PDF formats.
- The application program listing for the system as installed at the time of acceptance by ASU FSST

(FTP site update, electronic media, and all required passwords).

- Provide the name, address and telephone number of the authorized factory representative.
- A filled out Record of Completion per NFPA 72.
- Provide final Building Permit signed off.

1.5 Quality Assurance

1.5.1 Qualifications of Contractor Fire

Per RFP #171201 the fire alarm system shall be furnished and installed by awarded contractor **OR** as accepted by AHJ **AND** ASU’s Fire Systems and Support Technologies Supervisor.

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 45” keys shall be provided, appropriately identified, and turned over to ASU’s Fire Systems and Support Technologies group.

1.7.2 Warranty

The contractor shall warranty all materials, installation and workmanship for two (2) years from the 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 current RFP #171201 award winner shall be regularly involved in the installation, maintenance, and distribution of all products specified in this document. The products that are represented by the RFP Award winner 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. (EST3) products (as supplied by a licensed distributor to assure Campus Network compatibility) / (EST4) on all new Construction Projects (new builds) constitute the type of equipment to be installed unless otherwise approved by the AHJ **AND** ASU Fire Systems and Support Technologies Supervisor.

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 mass notification ready. The system shall capable of IP communications both Primary and Secondary as well as utilize independently addressed, microprocessor-based smoke detectors, heat detectors, and modules as described in this specification.

2.2 Panel Components and 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] / EST4 Network system installed in a **CAB-21 enclosure.**

- Each building system shall have at least one FACP with the following for communications to the campus FireWorks network:
- 4-CPU Central Processor Module
- 4-LCDLE 4-LCD w/ cable for 3-CAB5B, 7B, 14B, 21B, 4-8ANN, 16ANN and 24ANN mounting
- 3-SSDC2/3-SDDC2 Signature Dual Driver Controller. Mounts to local rail and takes one LRM

space. Supports two loops of Signature devices up to 250 detector and 250 module addresses. Supports one User Interface Module.

- 4-24L12S Control Display Module with 24 indicators and 12 switches
- 4-PPS/M Primary Power Supply w/ local rail module 120-240V 50/60 Hz.
- 4-CAB24DL Door Assembly – Bronze outer door and black inner door with 24 user interface spaces, mounts to 3-CAB21B wallbox.
- Switches, SIGA-UIO6Rn SIGA-MCR's for network communications disable along with switches to bypass individual control features. SIGA-UIO6's are unacceptable.
- All powers supplies shall be equipped as follows:
- APS10A Power Supplies Only; BPS6A, BPS10A, and APS6A are unacceptable.
- APS10A output circuits fed by SIGA-UIO6R/SIGA-MAB's shall be mounted within the enclosure.
- All Fire Alarm Control Panels shall have the following:
- CAB-21 Lobby style cabinets with LCD display
- Separate BC-1 for batteries, Space Age Electronics SSU00500 Battery Cabinet also approved.
- ALL Fire Alarm devices monitored or controlled by the FACP will be done individually by addressable module or addressable control relay.
- All addressable modules and addressable control relays shall be installed in an easily accessible location. Any question or concern on accessibility of devices or relays, contact the ASU FMO for guidance.
-
- Approved Fire Alarm Device Types:
- 4-NET-TP SFP Network Controller, 2Mbps Shared TX/RX, Twisted Pair
- 4-NET-SM SFP Network Controller, Single Mode Fiber
- 4-NET-CAT SFP Network Controller, CAT5 UTP Copper, 100Base-TX, 100Mbps
- 4-AUDTELS Audio and Telephone Interface/Riser Module
- 4-MIC Paging Microphone
- 4-FWAL1 Firewall – Provides secure connection to external systems. Support us to 8 concurrent IP connections supports connection to 4-USBHUB with printer and/or CDR3, SFP connection to FireWorks and other sup
- 4-FWAL-CAT SFP Network Firewall Adapter, CAT5 UTP Copper, 100Base-TX, 100Mbps
- 4-ANNCPU Annunciator Central Processor Unit (CPU), provides mounting for up to two network controllers, one USB device port, one USB host port and one 4-ANNAUDTEL module.
- 4-2ANNMT Mounting assembly for 4-2ANN, two wide annunciator. Supports surface or semiflush mounting. Comes with black wallbox, surface mounting plastic fillers and semi-flush trim.
- 4-LCDANN 4-LCD w/ cable for Annunciator enclosure 4-4ANN, 4-6ANN mounting
- 3-CAB21 FACP cabinet
-
- All supervisory, monitoring and alarm points to be individually monitored. Zoning of multiple devices is not permitted.
-

SIGA-OSD	SMOKE DETECTOR	USED WITH AN SIGA-SB4, PHOTO SMOKE
SIGA-HRD	HEAT DETECTOR	USED WITH AN SIGA-SB4, RATE-OF-RISE HEAT DETECTOR
SIGA-278	PULL STATION	
SIGA-SD	DUCT DETECTOR	
SD-TRK	REMOTE TEST STATION, KEYED	
SIGA-SB4	DETECTOR BASE	
SIGA-CC1/CC2	SIGNAL MODULE	
SIGA-MCC1/MCC2	SIGNAL MODULE	
SIGA-MCR	CONTROL RELAY	
SIGA-CRH	HIGH CAPACITY CONTROL RELAY	
SIGA-CC1S	SYNC OUTPUT MODULE	
SIGA-MCC1S	SYNC OUTPUT MODULE	
SIGA-UIO6R	UNIVERSAL I/O MODULE MOTHERBOARD	
SIGA-CT2	INPUT MODULE	
SIGA-MCT2	INPUT MODULE	
APS10A	REMOTE BOOSTER POWER SUPPLY	
SIGA-MAB	CLASS A/B MODULE	
G4AWF	HORN ONLY	
G4VWF	STROBE ONLY	
G4AVWF	HORN STROBE	
GP10	GENESIS Room-Side Wiring Plate, USE W/ ALL WALL AND CEILING MOUNTED GENESIS G4 LED SERIES STROBES AND HORN/STROBES	
G4SVWF	GENESIS SPEAKER STROBE (WALL MOUNT)	
GCSVWF	GENESIS SPEAKER STROBE (CEILING MOUNT IN HARD LID ONLY)	
GRSW	UNIVERSAL MOUNTING PLATE FOR SPEAKERS AND SPEAKER/STROBES	

- Any brand of devices and equipment may be accepted with prior approval of the ASU FMO.

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 applications 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 multiple communication ports and protocols including TCP/IP**
- Support up to 1740 chronological events in the panel buffer.

- 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.

Report to ASUPD's Fireworks Server/s.

- Provide electronic addressing of analog/addressable devices.
- Provide an operator interface control/display that shall enunciate command and control system functions.
- Provide a discrete 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 enunciate signals from devices and circuits installed throughout the building. Standard LED annunciators may be combined in common 6 ANN style enclosures with disable switches 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 enunciate alarm, supervisory and water flow 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 annunciator 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.
- Location of microphone in remote FAAP's shall be determined by AHJ.

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 enunciated 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 each control panel or booster the disconnect serves. Where a circuit breaker is the disconnecting means, an approved breaker locking device shall be installed.

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 report to the main monitoring station, such as FireWorks.
- 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 in the panel buffer.
- 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 and 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 settable 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 at 80%

2.3.1.2 Duct Detector Housing

Provide duct addressable duct detectors, such as or equivalent to EST Superducts. 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. Remote alarm LED indicators and remote test stations shall be provided. Each duct detector shall have a remote test station, key operated, installed in an easily accessible location in close proximity to the detector. The test station will be an SD-TRK. The test station shall be mounted no higher than 48” above finished floor.

2.3.1.3 Smoke Detector - Photoelectric

Provide 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 80% 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 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 SB-4

Provide standard detector mounting bases suitable for mounting on North American 1-gang, 31/2 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. 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 1/2 (64mm) deep 1-gang boxes and 1 1/2 (38mm) deep 4 square boxes with 1-gang covers, and shall be mounted at the required ADA height.

2.3.4 Initiation and 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 NACPS shall have individual module supervised class “A.” All ZA amplifiers to be Class A models.

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.

2.4 Conduits and Raceways

Conduit shall be sized per code, but shall not be less than ¾” unless pre approved by ASU.

FIRE ALARM SYSTEMS PART 3 - Execution

3.1 Installation

- All notification devices shall be wall mounted in a deep four (4) inch square box at a height of 84 inches from the finished floor to the bottom of the box; ASU may grant an exception to ceiling mount devices on a case-by-case basis.
- All notification device locations shall be verified on location for adequate coverage and correct volume.
- Any notification device that is not red in color shall have the word FIRE in red lettering embossed on the front of the device for identification that it is part of the fire alarm system and not any other alerting system. Notification devices connected to any other system shall be substantially different in sound, color, and appearance from fire alarm devices.
- Signal Line Circuits (SLC) and Notification Circuits (NAC) shall be installed in separate conduit runs.
- All Fire Alarm System wiring shall be installed in metal conduit that shall be red in color. Conduit shall be EMT and a minimum of 3/4-inch diameter, with compression fittings only.
- Flexible conduit may be approved for use in limited locations, primarily for use in tying in sprinkler system devices to the fire alarm system and for the installation of devices on drop ceilings and duct detectors in HVAC systems. Flex conduit shall be installed box to box, no pipe to flex conversion fittings shall be accepted. Flexible conduit not to exceed 6 feet in total length. The flex conduit shall be a minimum of 3/4-inch steel flex only (where applicable) with prior approval received before installation. Flexible conduit locations shall be indicated on the submitted plans or as a plan amendment during the project when and where identified. ½-inch flexible conduit will be allowed for connection to devices with only ½-inch knockouts, such as duct detectors, waterflow switches, and tamper switches. Flexible conduit in any other location shall not be accepted.

- Conduit shall be mounted to the permanent structure, where unable to mount to the permanent structure the conduit may be supported on minimum ¼-inch all-thread with minerallac style nut/bolt hangers where applicable. “Bat Wings” will be accepted when installed on a minimum ¼-inch all-thread.
- Vertical risers when installed shall be of a minimum of 1 inch diameter, Red in color, Electrical Metallic Tubing (EMT), terminating at a minimum of a 12x12 inch box at each floor, all connections shall be of Compression Fittings only, no flex conversion fittings will be accepted.
- All Notification Appliance Circuits shall be Class A, and shall use a minimum of #14 AWG (0.08 inches) Stranded Copper Wiring.
- All Signaling Line Circuits (SLC) shall be Class A, and shall use a minimum of #16 AWG (0.064 inches) Solid FPLP Yellow in color.
- Horn strobes 14 AWG (0.08 inches) minimum-Stranded wire, color pair groups in order as follows;
- Red/Black
- Yellow/Blue
- Orange/Brown
- Gray/Purple
- Speaker Circuits 16 AWG (0.064 inches) Solid FPLP Purple in color
- Signaling Line Circuits (SLC) Class A, 16 AWG (0.064 inches) Solid FPLP Yellow in color.
- SLC cable pulled in separate conduit from NAC cabling.
- Wiring terminations are device to device only. Splices, and /or wire nut terminations are not permitted or acceptable.
- All fire alarm devices shall be monitored or controlled by the FACP individually by means of an addressable module or addressable control relay.
- All fire alarm conduit that is approved to be painted by the ASU FMO shall have labels affixed to the conduit in the areas between 1-3 or 9-11 as in clock direction on the conduit as to be visible for maintenance and identification. The labels shall be red lettering on a white background, .500 inch wide minimum tape with .250 inch minimum red lettering stating "FIRE ALARM" in capital letters. The labels shall be installed at the maximum interval of 10 feet.
- Any piping and/or conduit to be painted shall be inspected/approved by the ASU FMO prior to any painting to take place.
- All conduit installed with this project shall be inspected by ASU Fire Alarm Technicians. Contact Dale Munday at dale.munday@asu.edu to coordinate setting an inspection schedule

3.2 Sequence

Installation of the systems shall be conducted in stages and phases 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 and AHJ.
2. All fire system conduits must be in red EMT using compression fittings in a CLASS A configuration.
3. Wiring terminations are **device-to-device only. Splices and/or wire nut terminations are NOT acceptable.**
4. Pre-test the audible and visual notification appliance circuits by installing contractor.
5. Install all new detection devices.

6. Terminations between field devices and the associated control equipment.
7. Complete contractor pre-test of the entire system before ASU Fire Systems and Support Technologies are called to provide pre-acceptance testing.
8. Complete system testing with AHJ, installing contractor and ASU's Fire Systems and Support Technologies representative.

3.3 Special Installation Instructions

All installation procedures and methods are subject to inspection and approval from Capital Programs Management Group and AHJ.

The installing contractor **shall be** 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.** If surface raceways are required, coordinate with Project Manager for an acceptable solution.

3.4 Field Quality Control

3.3.1 Test and Inspection

3.3.2 Conduit Inspection

All conduit installed shall be inspected by ASU Fire Alarm Technicians prior to the installation of field wiring. Contact Dale Munday at dale.munday@asu.edu to coordinate setting an inspection schedule.

3.3.3 Wiring Inspection

All fire alarm wiring shall be inspected by ASU Fire Alarm Technicians prior to the installation of devices. Contact Dale Munday at dale.munday@asu.edu to coordinate setting an inspection schedule.

3.3.3.1 Pre-Acceptance Test and Inspection

A pre-acceptance inspection shall be completed by ASU Fire Alarm Technicians prior to ASU FMO personnel conducting the final fire alarm system acceptance inspection. The contractor must provide a completed NFPA 72 System Record of Completion detailing all Contractor Pre-test results, and must also provide the system SDU programming when requesting scheduling of the pre-acceptance inspection. Fire alarm contractor shall provide a points list 5 days prior to pre-acceptance inspection. Contact Dale Munday at dale.munday@asu.edu to coordinate setting an inspection schedule.

All smoke detecting devices shall by means of a fire alarm panel report indicate they are testing at 0% dirty at the time of the ASU Fire Systems Pre-Acceptance Testing. Any devices that are not testing at 0% dirty shall be cleaned or replaced by the project. Any devices that cannot reach the 0% threshold shall be considered defective and will not be accepted by ASU.

- All intelligent addressable devices shall be tested for current address, sensitivity, device location and user defined message.
- All wiring shall be tested for continuity, shorts, opens and grounds before the system is activated.

- The installing contractor shall provide instruments, tools and labor required to conduct the tests available. The person performing the tests shall be minimum NICET level II or CSA cardholder. The installing contractor shall also have the approved fire marshal plans and permit.
- All testing to the system shall be done in the presence of ASU's Fire Systems and Support Technologies.
- The system, including all its sequence of operations, shall be demonstrated to the Owner, his representative, and ASU's Fire Systems and Support Technologies department. **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** ASU's Fire Systems and Support Technologies department.

3.3.3.2 Final Acceptance Test and Inspection

At the final test and inspection a NICET level II or CSA cardholder from the installing contractor shall demonstrate that the system functions properly in accordance with these specifications in the presence of an AHJ, a representative from ASU FSST and the project GC (if applicable)**:**

- Prior to any test by AHJ, a complete system with no troubles, supervisory, or alarms on the FACP (Green Panel) must be confirmed.
- Testing will be at the discretion of the AHJ in conjunction with the ASU's Fire Systems and Support Technologies crew.
- Stamped/approved plans and permit by the AHJ must be on site to review for testing and any alterations to approved plans must be pre-approved by AHJ. The AHJ 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 ASU FSST and others at their discretion. A copy shall also be left on site in a designated "AS- BUILT" box installed next to the FACP.
- 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 ASU FSST.
- 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 work order 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.
- 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 Fire Systems and Support Technologies.

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 sculptural effect, proper site drainage, lawns, shrubs 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, infiltration wells or as a final option, drywells.

The PM is responsible for obtaining a soils report that will become the guide for earthwork activities. A current report is required for all work.

Inclusion of the Soil Report in the specifications is not permitted on ASU projects. The report shall be made available to the engineers and contractor.

Earthwork shall be designed by appropriately licensed (Civil) engineering consultants. No attempt is made here to define the consultant's duties and responsibilities for normal professional practice. This guide identifies specific items of concern to the University that are earthwork related. The DP and his consultants are totally responsible for the adequacy of the design and contract documents.

All earthworks is to be designed to be in conformance with all applicable codes, ordinances and laws governing this work. Proper erosion and sediment controls must be in place to prevent sediment or silt runoff. The DP is to address appropriate regulations which may include 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 control must be carefully defined in the contract documents.

Design Standard

A. Fill

1. ASU is a long term building owner. Many projects have experienced site settlement long after the contractors have completed the projects. This settlement is a direct result of lax contractor practices and a lack of oversight during compaction processes. The DP will carefully define compaction parameters and practices. The DP will also have qualified personnel on site during compaction activities so that the specifications are met during construction activities.
2. The Owner will retain and pay for the work of testing agencies who will oversee (under the supervision of the DP) the contractor's compaction practices. The documents are to require the Contractor to immediately correct any inadequate practices or failed compaction areas.
3. This testing and observation applies to all areas of fill including trenching that may be discussed in other areas of these guidelines.

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 or site is located.
2. 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. Installation of any and all drywells require an ASU Building Permit It is preferred that the use of infiltration wells, micro basins and other sustainable measures be incorporated into the site grading and stormwater management plan.
3. The use of sump type pumps for exterior surface drainage is not allowable.
4. All areas to be planted with grass, ground cover or plantings shall receive a minimum of 12 inch topsoil and the subgrade scarified to a depth of 6". See Landscape Guidelines.

5. All finish grades shall be a minimum of 1/2 inch below adjacent walks, drives, curbs, mow strips and paving.
6. Certification of installation for underground retention systems, such as Storbrixx or similar, shall be provided to verify system installation per the mfgr requirements.
7. The DP shall provide as-built plans sealed by a surveyor or the Engineer of Record with the as-built retention volume. The EOR shall certify the as-built retention volume on the as-built plans or in a sealed Drainage Memorandum that includes the statement that "the drainage infrastructure has been constructed in general conformance with the approved plans and will function as designed.
8. 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, plant materials, retention, travel, stormwater drainage, or aesthetics.

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. The DP will visit the site with the PM and representatives of various ASU departments to carefully review existing site conditions. The contract documents will identify any special features that are to receive special treatment.

B. The DP will provide adequate direction for the protection and preservation of site elements to be retained. These may include constructed items and tree specimens.

C. Items to be protected during construction must be clearly defined and the protection including watering is to be clearly stated. Include notes requiring the contractor to provide at no cost to the owner replacement elements in the event that the contractor allows items to become unusable during his construction process.

D. The GC is to notify the PM a minimum of 72 hours in advance of any site preparation activity.

E. ASU reserves the right to relocate, remove, or demolish any heritage tree, memorial tree, or special collection. This shall be coordinated with the PM, OUA and ASU Grounds.

F. The contractor is to be required to carefully coordinate site preparation activities with ASU departments so that disruption to the campus environment is minimized. The DP is to carefully identify those departments with the assistance of the PM.

G. The DP is to provide heightened awareness to the contractor that subsurface utility investigation at the University is a very serious issue. The DP and PM are to carefully define the various entities who will provide this exploration and mapping service.

H. Subsurface investigation is to be conducted by properly licensed firms. On site and off site investigations are typically performed by different companies. The DP is to coordinate this carefully with the PM so that the documents reflect the correct entities for different locations.

I. Archaeological clearances are necessary at all ASU sites. The DP is to carefully coordinate this aspect of the work with the PM.

31 10 01 – Temporary Tree and Plant Protection

Description

This section contains standards for protection of in-place and trimming of existing trees that interfere with, or are affected by, execution of the work, whether temporary or permanent construction. The contractor is to coordinate with the FM Grounds and the Office of the University Architect to review all trees on site that may conflict with the proposed site work.

Tree Protection Zone will be the area surrounding individual trees or groups of trees that are to remain during construction, defined by the **perimeter drip line** of individual trees or the perimeter drip line of groups of trees, unless otherwise indicated. The protection zone will be outlined by chain-link fence panels of temporary fencing and the area of protection will be covered by coarse bark mulch. Temporary snow fencing, jersey barriers or other boundary measures that can be easily moved are not to be used unless expressly approved by FM Grounds in writing. Any plant material used to replace damaged plant materials shall be new plant material as approved by FM Grounds.

Design Standard

General

A. Site Preparation:
  - a) Locate and flag with surveyor's tape trees and vegetation that are to remain or to be removed.
  - b) Engage a Certified Arborist to direct pruning of trees to remain on site.
  - c) Install temporary fencing around tree protection zones to protect remaining trees and vegetation from construction damage. Protection fencing shall be included on the project fencing plans. Maintain temporary fence and remove when construction is complete.
  - d) Mulch tree protection areas with organic matter to a depth of 3 inches.
  - e) Protect tree root systems from damage caused by runoff or spillage of noxious materials while mixing, placing, or storing construction materials. Protect root systems from ponding, eroding, or excessive wetting caused by dewatering operations.
  - f) Do not store construction materials, debris, break areas or excavated material inside tree protection zones. Do not permit vehicles or foot traffic within tree protection zones; prevent soil compaction over root systems. Locate portable restrooms outside tree protection zones.
  - g) Maintain tree protection zones free of weeds and trash.
  - h) Arrange with FM Grounds for regular irrigation of protected trees.
  - i) Arrange with FM Grounds to maintain viability of the adjacent planting and turf areas during the construction process. The contractor will verify that upon the completion of construction that the irrigation to the adjacent area is connected and in good working order.

B. Excavation:
  - j) Install shoring or other protective support systems outside the tree protection zone to minimize sloping or benching of excavations onto the tree root zone.

  - k) Outside the Tree Protection Zone:
    - i) Shovel is to be pulled away from the edge of tree protection zone. If roots are greater than 1 inch in diameter are encountered outside the tree protection zone, the Certified Arborist shall be consulted prior to pruning these roots.
    - ii) Roots encountered during excavation will be redirected into the backfill areas where possible. If large, main lateral roots are encountered, the excavation limits will be extended as necessary to expose roots to a length as required to bend and redirect them into the backfill without breaking. If encountered immediately adjacent to location of new construction and redirection is not practical, cut roots cleanly 3 inches back from new construction.

      iii) If tree roots larger than 1 inch in diameter require pruning due to construction activities, a Certified Arborist shall be consulted prior to pruning.
      iv) Roots exposed during excavation will be protected to prevent drying until permanent backfill is placed.
      v) Exposed roots will be covered with temporary earth cover or packed with peat moss, wrapped with burlap and regularly watered to, maintain in a moist condition.
      vi) Exposed roots will be temporarily supported and protected from compaction and damage until they are permanently relocated and covered with soil.

   l) Within the Tree Protection Zone:
      i) Where excavation for new construction is required within tree protection zones, do not proceed without the FM Grounds written approval. Hand clear and excavate to minimize damage to root systems. Comb soil to expose roots using narrow-tine spading forks.
      ii) If tree roots larger than 1 inch in diameter require pruning due to construction activities, the Owner’s Certified Arborist shall be consulted prior to pruning.

   m) Utility Trenches: Where utility trenches are required within tree protection zones, do not proceed without the written approval. Tunnel under or around roots by drilling, auger boring, pipe jacking, or digging by hand. Use existing utility locations where possible.
      i) Root Pruning: Do not cut main lateral roots or taproots; cut only smaller roots that interfere with installation of utilities. Cut roots with sharp pruning instruments; do not break or chop. Do not apply any material to cut faces of roots.
      ii) If tree roots larger than 1 inch in diameter require pruning due to construction activities, a Certified Arborist shall be consulted prior to pruning.

2) Regrading
   a) Minor Fill: Where existing grade is 6 inches or less below elevation of finish grade, fill with topsoil. Place topsoil in a single un-compacted layer and hand grade to required finish elevations. Do not grade so that the tree trunk is in low spot after finish grading.
   b) Change of grade beyond 6 inches: Where existing grade at tree protection zone differs by more than 6 inches from finish grade, construct retaining walls to keep original grade under tree.

3) Hardscape around trees
   a) In parking lots, allocate 8-foot x 8-foot uncovered space for trees preserved on site. Asphalt cover: Irrigate tree protection zone well the night before. Slope asphalt slightly into the planting pit. Flood irrigate again after asphalt installation.
   b) Concrete and impermeable paving: Flood irrigate tree protection zone the night before pouring. Protect tree zone from traffic, trash, or backwash during concrete pour. Irrigate trees again the following day.
   c) Structural Soil, Structural Cells, and alternative media: Flood irrigate tree zone well the night before. Protect tree zone from backwash or trash during installation of aggregate. Irrigate again the next day.

i) Tree repair and replacement
   d) Notify the FM Grounds immediately if trees and shrubs to remain in place are damaged during construction. Do not repair damage except with the Owner’s Arborist written direction.
   e) Promptly repair trees damaged by construction operations within 24 hours of damage. Treat damaged trunks, limbs, and roots according to FM Grounds written instructions.
   f) Trees indicated to remain on the site which die or are damaged during construction that FM Grounds Staff Arborist has determined are incapable of restoring to normal growth pattern will be removed and replaced during construction operations at no cost to ASU.
   g) Provide new trees of the same size and species as those being replaced; plant and maintain these trees.
   h) All costs of repair or replacement will be assessed to the contractor.

31 23 00 - Excavation and 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 construction process.

Design Standard

A. No effort is made here to outline normal items that the DP and his consultants are to address in their specifications and drawings related to this activity. Only items of concern to ASU are outlined here.

B. All areas to be excavated or shored must be barricaded or fenced from pedestrian or vehicular traffic.

C. 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).

D. The contractor will have on site a full time safety officer during all excavating and shoring activities. The safety officer will monitor all activities continuously so that the possibility for unforeseen difficulties is avoided. The safety officer shall provide his daily activity logs to the PM at the end of each working shift.

E. 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 PM.

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, the Contractor shall certify application rate.

5. Contractors shall notify ASU Grounds 24 hours in writing 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, (as provided by Arizona Bag Co. LLC or approved equal), which allows water to penetrate yet keeps weeds in check.

D. Arizona School Boards Association Reporting Hazards/Warning Systems:

1. Pest-control applicators shall provide the school contact person, through the General Contractor, with written or electronic 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, the 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 pre-application notification containing the following information:
   a. The brand name, concentration, the 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.

31 36 00 - Gabion

Description

This section defines the use and implementation of the rock filled wire baskets as a functional and design item in site development for new projects. The use of gabions will be reviewed on a project basis but primarily will be used on the Polytechnic campus.

Design Standard

A. The design and construction of the gabion baskets will conform to the manufacturer's literature and all associated appurtenances. Wire for the manufacture and assembly of gabions shall be non- galvanized and non-coated black steel wire and Welded Wire Mesh (allowed to rust naturally) and shall meet or exceed all of the following requirements:

Description	**Requirement**
3"x3" (9 ga. - 0.144 in. min.) Welded Wire Fabric	ASTM AI85
9 ga. Pre-Formed Stiffener	ASTM A82
9 ga. Spiral Binder	ASTM A82
13.5 ga. Tie Wire (temporary)	ASTM A641

B. Suggested manufacturer: ARTWELD GABIONS as manufactured by Hilfiker Retaining Walls, 3900 Broadway, Eureka, CA. USA 95503. http://hilfiker.com or approved equal.

C. Sample mockups shall be erected two complete gabion mockups utilizing two foot (2') basket heights, including stone placement and reinforcing posts, for review and approval of both technical and aesthetic installation results by OUA.

D. Gabions shall be of a single unit construction in the following sizes: 3' width x 3' height x 6' (max.) length and 2' width x 2' height x 6' (max.) length; internal cells of equal three (3) foot spacing with diaphragm panels made of the same wire mesh used for the gabion body. Each gabion shall be fabricated with the manufacturer's spiral binders connecting the panels at the base.

E. The base, ends, sides, and lid shall be fabricated from 3" x 3" x 9-gauge, non-galvanized, non- coated, black (allowed to weather naturally) Welded Wire Mesh and connected in such a manner that strength and flexibility at the connections are at least equal to that of the wire mesh.

F. The gabions shall be fabricated in such a manner that they can be assembled at the construction site with Spiral Binders and pre-formed hooked stiffeners to form rectangular baskets of the specified size.

G. The length, width, and height of the gabion assembly shall not vary more than 5 percent from the dimensions shown on the plans.

H. Each shipment of gabions to a job site shall be accompanied by a Certificate of Compliance.

H. Rock for filling the gabions will be 100% passing 6" and 2% or less passing 3". Rock to be clean, free of nicks and fractures and placed in gabions per the manufacturer’s instructions.

I. If required, soil filtering fabric shall be a non-woven, Geo-Textile Fabric, 8 oz./square foot fabric cloth.

J. The exposed face or faces of the gabions are to have the rock handset. As much as possible, the flat face of a rock is to be tightly spaced against the wire mesh. Proper rock placement will provide a "stacked stone" appearance. Rock behind the face stones can be randomly placed in a manner to minimize voids and settlement.

At curved or radiused walls - modify the faces of gabion baskets to achieve a continuous radius. Retain the front face (outside radius) of the basket to maintain the basket's standard horizontal face dimension along the outside wall radius. Configure the horizontal length of the back basket face (inside radius) to conform to the walls inside radius. Curves are to be smooth and even in appearance.

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 and Transit Services, ASU Department of Public Safety, OUA Coordinator of Accessibility Compliance (ADA Accessibility Standards), Facilities Management (Best Practices) as well as any additional local, state of federal regulations governing this work.. The DP is to obtain formal written approvals of the design concept from these entities at the completion of the SD, DD, and CD phases.

All new AC pavement and AC Pavement maintenance design and specifying shall be performed by a properly licensed Pavement Designer/Consultant or a Civil Engineer. Pavement is an extremely important aspect of the infrastructure. ASU requires that Engineers who are tasked with pavement design must prove in written format that the **specific individual** performing the design and specifying work **is a specialist** in this area. If that expertise is not available within the firm, the consultant will be asked to retain the services of a suitable expert for these tasks.

Design Standard

New Pavement

A. All new pavement design shall be based in part on a current soils investigation report. This report will be prepared by a qualified individual and sealed as an instrument of professional practice. The report shall make specific recommendations for the pavement types and sections that are used in these specific locations for the intended use.

B. A pavement designer will design all new pavement and pavement maintenance system components.
  a. The Pavement designer shall be a specialist within the firm or an independent consultant.
  b. In no instance will the pavement designer be affiliated with or an employee of a contracting firm performing pavement or pavement related work.

C. The pavement designer will use the results of the soils report and his expertise in designing pavement sections adequate for their intended use.
  a. The pavement designer may exceed the recommendations that are made in the soils report as long as he has the knowledge and approval of the PM.
  b. In no instance is the pavement designer to design sections that are below the recommendations contained in the soils report.

D. The University expects all pavement to have a usable life span of a minimum of 15 years.

E. Parking stall layout, traffic circulation plans, signage and other necessary or required pavement accessories are to be designed and specified by a traffic control specialist.

F. Where possible, to reduce the urban heat island effect, utilize permeable surfaces to reduce runoff and reflective surfaces.

Pavement Maintenance

A. Pavement Maintenance will also be evaluated and designed by an independent pavement consultant or specialist civil engineer in the same manner as described above.

B. The consultant shall evaluate the condition of the area to be maintained and will quantify the defects encountered on a scale plan of the area.

C. The defects will be identified as to type and the severity of the deterioration. These locations will be marked out in the field with a paint material that will remain visible for at least 30 days.

D. The consultant will recommend the specific types of repair work that are to be performed: Crack Seal, Skim Coat, Slurry Seal, Seal Coat, Remove and Replace, Overlay.

E. Each type of maintenance repair is to have a specification created that outlines repair materials and construction practices that are to be utilized during the repair.

F. The document supplied by the consultant is to be adequate for the purpose of obtaining bids necessary for the work.

G. The consultant will specifically indicate aspects of the work that are adversely affected by various weather conditions expected during the project. There are some types of work that simply are inadvisable during the hottest summer months.

Pavement Quality Control New And Maintenance Work

A. The consultant will be retained to oversee the contractors' materials, practices and procedures necessary during the pavement work.

B. The consultant will review material specifications, transit tickets, to assure that materials are as specified. Nonconforming items will not be accepted and will be removed from the property.

C. The consultant shall approve the commencement of work at each sequential step in the specified process.

D. The consultant will be the judge of the necessity for soils testing or soil remedial activities that may include:
   a. Severely damaged or damp sub base.
   b. Unknown conditions.

E. Requirement for over excavation and re-compaction of base course.

F. Any other defect that the consultant believes will degrade the installation.

G. The consultant will issue a notice of completion of the work to the DP.

H. The consultant will assist the PM in completing the contractor evaluation form.

Pavement Layout and Striping

A. Parking striping shall be performed by a specialist in this area.

B. Striping materials shall be specified by the DP and/or Consultant and may be based on regional standards like the Maricopa Association of Governments (MAG) specifications.

C. Striping and other marking paint is to last three years without recoating. The DP and/or Consultant is to ensure that the specified materials and mill thicknesses are provided in the field.

D. After the layout is marked on the pavement but prior to the application of the striping and marking paint, the PM, DP and/or Consultant are to all walk the area. They are to review the actual layout and ensure that it meets the design intent. Modifications may be made at that time based on the field conditions and the approval of the PM.

Miscellaneous

A. No asphaltic concrete curbing or driveway aprons are allowed.

B. It is recommended that a seal coat be applied after new pavement has aged for 12 months.

C. Asphaltic concrete pedestrian walkways can be used for temporary means of egress. Permanent asphaltic concrete pedestrian walkways are discouraged at ASU. If approved by the PM, they shall conform to the same criteria cited above.

D. Minimum parking stall size is 9’-6” x 18’-0”, handicap accessible stalls shall be per Americans with Disabilities Act.

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. These installations are typically not designed and specified by an engineer or architect as a part of a larger project. On larger projects the DP is responsible for all aspects of the design and subsequent approval by the University.
This section specifically does NOT APPLY to any hardscape walks that are a part of the University wide fire safety system or walkways that will be used regularly for vehicular traffic or cart access. Cement pavement for these types of uses are to be designed by the appropriate engineers to defined criteria, standards and quality control.
Tempe campus - For major malls, nodes and gateway areas, refer to the Tempe Campus Mall Hardscape Master Plan (TCHMP) for material and finish specifications. This document is available from OUA. In regards to the sustainability aspects of paved services and to reduce the urban heat island effect, utilize permeable surfaces to reduce runoff and reflective surfaces where possible and appropriate.

Design Standard

A. 6' width minimum in areas of pedestrian travel, including collector walks at residence hall buildings pedestrian volume and density will be a design consideration. Paving continuing or connecting major mall travel ways or major/significant building entries shall conform to the TCHMP and be of a width justified by traffic volume and aesthetic precedent.

B. All curb cuts, ramps and level transition shall conform to applicable governing standards including the Americans with Disabilities Act.

C. Sidewalks shall be 6 inches of concrete over 4 inches of base course compacted to 95% density.

D. Topcast 05 Finish/medium sandblasted finish unless otherwise noted.

E. Per the TCHMP, integral color concrete (Palomino) will be used on all pedestrian hardscape areas on the Tempe campus and approved by OUA.

F. Expansion joints at 18' maximum in a single run of paving.

G. Scoring or joints to be at the same interval as the design width of the subject travel way for areas NOT governed by the TCHMP.

H. An additional 2' 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.

I. Walk intersection corners shall be rounded and at all grade changes shall have appropriate curb cuts and transitions that allow full and equitable accessibility and safety.

32 13 16 - Decorative Concrete Pavers

Description

Special concrete material pavers that are intended primarily for pedestrian areas.

Design Standard

A. Designs using pavers must be approved by the Office of the University Architect. For installations on the Tempe Campus, the Design Professional (DP) shall reference the Tempe Campus Hardscape Master Plan (TCHMP) for designated paver locations.

B. All pavers installations are presumed to receive light to heavy duty vehicular traffic.

C. Pavers are to be manufactured cast concrete units, 8 cm thick. In certain applications 6 cm pavers will be allowed upon approval from OUA.

  a. Approved colors (by Belgard):
    i. Desert Sand
    ii. Raven
    iii. Burnt Umber
  b. Approved finish:
    i. Ground Face (GF)
    ii. Unpolished
    iii. Unsealed

D. Edges abutting another material (landscape, building walls, etc.) shall be mud set on a concrete waste slab/footing. Where appropriate, ½" thick x 6" steel edging can be used in conjunction with the mortared edge.

E. The method of setting pavers is on a 1" sand bed over a 6" thick Class AA concrete slab on 6" compacted AB or as directed by the soils report.

F. Top dress the set pavers with polymer sand and sweep/vibrate into place.

Quality Control

A. All adjacent grade elevations are to be taken into consideration when laying out these areas.

B. Paver elevations are to be 2" above the adjacent planting area grade elevations, 1" above turf areas and flush with hardscape areas unless otherwise stated.

C. The drainage of adjacent site areas is not to be blocked by the paver areas.

D. Completed paver areas will drain into adjacent landscape areas, not retain water or exhibit ponding of incidental water.

32 31 10 - Exterior Enclosure Design Guidelines

Description:

The Exterior Enclosure Design Guidelines are intended to provide guidance to the design professional (DP) as well as internal ASU stakeholders on the design, look, placement, color and other such aesthetics to our ASU fencing and exterior yard enclosure solutions.
Each project and end user situation is unique and these Guidelines provide direction and a framework for

the design team and ASU agents to work within to achieve the project goals as well as align with the University's design goals and aspirations as set forth by our CFO and the University Architect.

The ASU campuses are comprised of many buildings, exterior areas, walkways, plazas and landscape areas. As such, there are areas that are undesirable to view such as 'back of house' areas, trash collection areas and utility and equipment yards. The University has established a uniform aesthetic of look, color and branding to enclose these areas.

The goal of these guidelines is to expedite the project schedule while maintaining University standards. Exceptions to any design standard may be discussed with the University representatives as appropriate. These guidelines will evolve and be further refined as they are applied to various projects as new situations and needs arise.

Design Standard:

A. The enclosure standard consists of a combination of CMU wall and water-cut steel ASU see-through fence.

B. The fencing comes in 4'-0" wide x 2'-6" tall sections as well as 5'-0" wide x 2'-6" tall sections. These can be stacked in various combinations to create varying heights and widths of enclosure fencing.

C. The typical height for trash enclosures and equipment yard enclosures shall be 7'-6" high (3 panels).

D. All enclosures shall have access gates appropriate to the use and function of the enclosed yard.

E. Double swinging gates (4'-0" wide) with concealed heavy duty piano hinges are the most common access gates for most purposes.

F. Manual and electric sliding gates shall be used on openings requiring larger sizes such as trash compactor equipment yards for truck access etc.

G. The fencing shall be constructed out of 12 gauge steel panels with water-cut design. See exhibits.

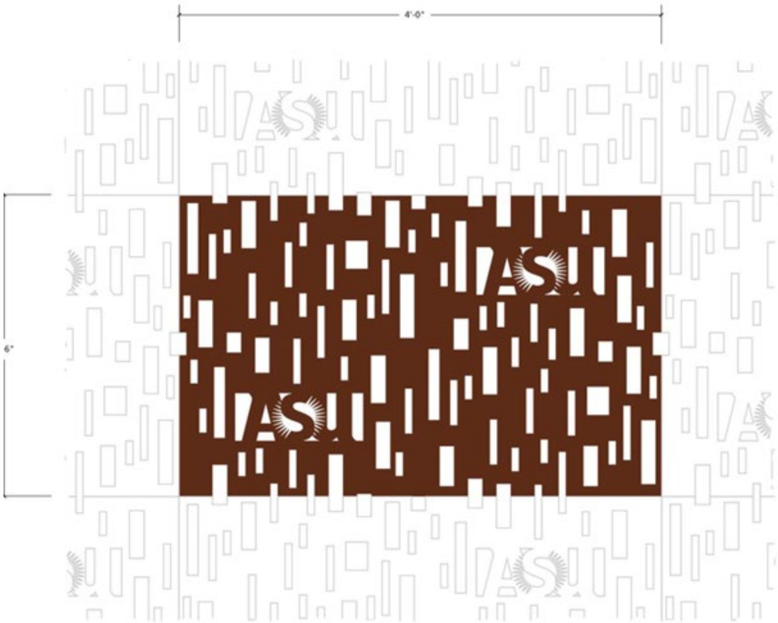
H. The fencing shall be either satin brushed nickel or Electro-statically painted to match Frazee CL2607N "Wallabie".

I. The DP shall submit construction drawings, colors and samples to the Office of the University Architect for approval.

J. For all academic areas, the ASU Sunburst logo fencing shall be used. (See exhibits)

K. For all areas that pertain directly to ASU Athletics, the Pitchfork logo fencing shall be used. (See exhibits)

Exhibit 1 – Typical ASU Enclosure Fencing



Scale: 1 1/2" = 1'-0"
12 ga Steel - Electro-statically painted to match Frazee CL2607N "Wallabie"

Academic Areas

Exhibit 2 - Typical ASU Enclosure Fencing

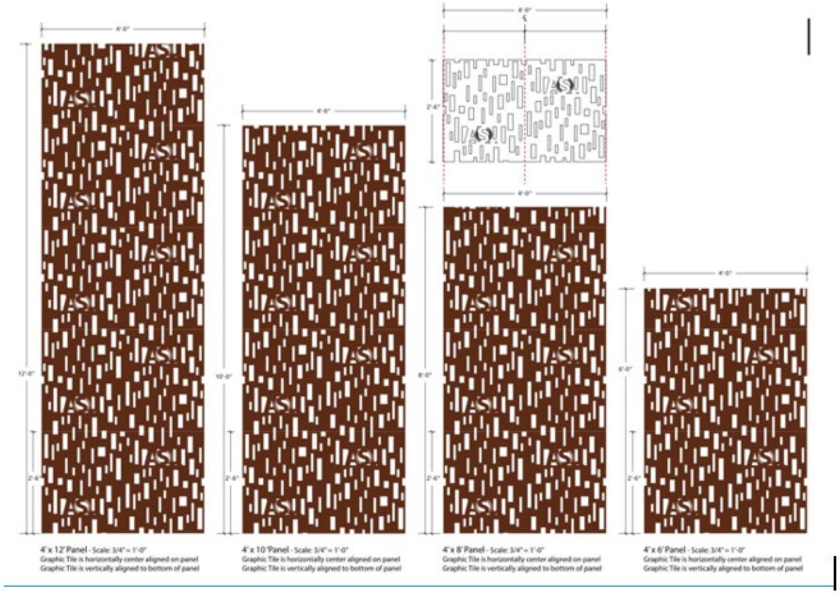


Exhibit 3 - Typical ASU Enclosure Fencing with CMU Wall

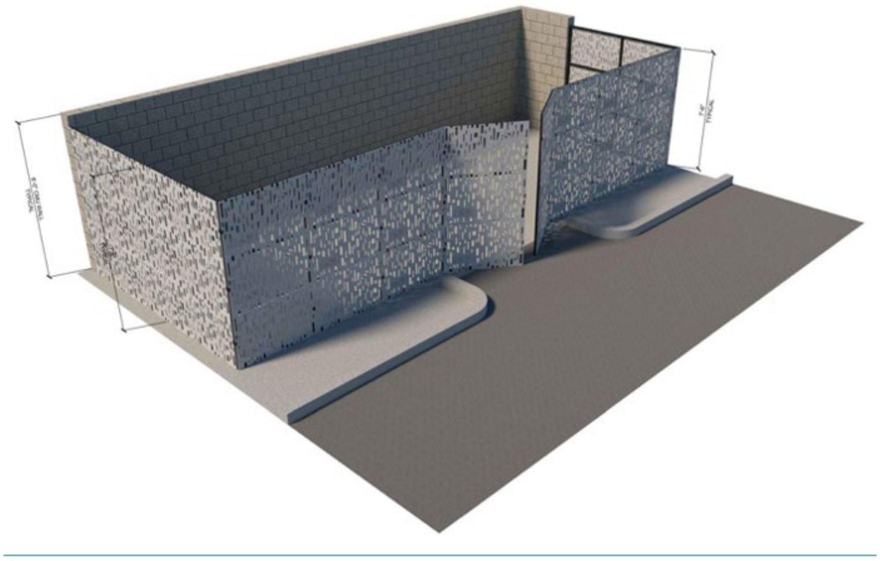


Exhibit 4 - Typical ASU Enclosure Fencing Example

32 84 23 - Sprinkler Irrigation Systems

Description

This section applies to capital and renovation projects containing landscaped site areas with permanent irrigation. Work of this section covers conventional in-ground irrigation only and does not include irrigationby any other means. The determination of required irrigation work will be made during the project scopedefinition.

Section Standard

A. In keeping with the University's sustainability goals, the irrigation system shall be designed for maximum efficiency and water-conservation.

B. An automatic irrigation system is required for any project containing turf, planting beds, raised planters or planter pots.

C. Irrigation work may be based upon one or any combination of the following:
   1. Restoration/repair of existing system.
   2. Select component upgrade.
   3. Construction/installation of a new irrigation system.

D. ASU FM Grounds and Office of the University Architect (OUA) shall review and approve the irrigation scope of work as soon as possible in the Project Development.

E. Irrigation work includes, but is not limited to the following:
   1. Automatic controller, foundation (if required), conduit, switched power supply.

2. Trenching, stockpiling, excavation and backfill.
3. Water connections including meter, backflow prevention assemblies.
4. Piping, valves, fittings, spray heads and drip assemblies, sensors, control wiring, communication cabling.
5. Testing, inspection, and approval.
6. Maintenance, warranting and replacement of any and all irrigation materials and/or products.

F. Irrigation water supply shall be based on the following:
   1. A metered water supply is required for all irrigation systems.
   2. Metering shall include a flow sensor connected to the automatic controller along with a secondary mechanical analog meter.
   3. Irrigation systems may be connected to a building or directly from a city water supply.
   4. All water supply sources including non-potable water and metering requirements to be approved by the Owner.

G. Work may also include keeping existing plant material watered and irrigation systems operational during construction. Manual watering and/or provision of a temporary water source may be required.Contractor will be responsible for all costs incurred during temporary watering efforts. Contractor will replace and pay for any existing plant material damaged due to inadequate watering. Coordinate with and obtain approval for all temporary watering methods from ASU FM Grounds.

H. Irrigation design shall meet all applicable laws, codes, ordinances, rules and regulations. Conform to the requirements of reference information listed below, except when more stringent requirements are specified.
   1. American Society for Testing and Materials (ASTM) – Specifications and test methods.
   2. Underwriters Laboratories (UL) – UL wires and cables.
   3. National Fire Protection Agency (NFPA) – National Electrical Codes.
   4. American Society of Safety Engineers (ASSE) – Performance requirements for backflow preventers/assemblies.

I. Irrigation planning, design and installation shall follow the 2023 Arizona State University Irrigation Master Plan Update and Standard Irrigation Details in conjunction with these section standards.

J. Submit manufacturer cut sheets on all material components for approval prior to construction.

K. Automatic Controller – model to be verified with FM Grounds
   1. Hunter Industries, model A2C-1200-M 12-station, gray steel wall mount
      - 6-station plug-in module: A2M-600 (as required)
      - A2C-LTEM cellular communication module
      - PED-SS, stainless steel for pedestal installations
   2. Hunter Industries, model I2C-800-M 8-station, gray steel wall mount
      - 8-station plug-in module: ICM-800 (as required)
      - CELL-KIT cellular communication module
      - ICC-PED-SS, stainless steel for pedestal installations
   3. Number of Stations: per design, conventional wiring (2-wire not permitted)
   4. Flow monitoring/management: per each point of connection

L. Submit manufacturer cut sheets on all material components for approval prior to construction.

M. Backflow Preventer – Febco 825YA

N. Master Control Valve – per point of connection:
   1. 1”: Rainbird PES
   2. 1 ½” or greater: Rainbird EFB-CP

O. Flow Meter – Creative Sensor Technology, model FSI T series PVC flow sensor

P. Electric Control Valve:
   1. 1”: Rainbird PES
   2. 1 ½” or greater: Rainbird EFB-CP
   3. No valves smaller than 1 inch.

Q. General piping:
   1. **Class 200 piping not allowed for any application.**
   2. Pressure Supply Lines (downstream of backflow prevention units) – Schedule 40 PVC, Solvent Weld Belled End for 2 ½” or smaller, and rubber-ring joint for 3”and larger with ductile iron fittings.
   3. All mainlines shall be looped whenever possible so as to improve pressure and flow.
   4. Non-pressure lines shall be Schedule 40 PVC, Solvent Weld Belled End.
   5. All piping for non-potable water systems shall be purple colored or wrapped with reclaimed “sock” or reclaimed marking tape, and main lines shall have detectable reclaimed marking tape in trench 12” above top of pipe continuously.

R. Drip Piping – Schedule 40 PVC, Solvent Weld unless otherwise specified on plans.

S. Emitter Tubing – ¼” I.D. vinyl Pepco or approved equal.

T. Low Pressure / Volume Systems:
   1. Emitters shall be Agrifim Super-Flo or Bowsmith.
   2. Bubblers shall be adjustable (Irritrol 533.) or fixed rate (Rainbird 1300/1400) depending on application. Verify type with ASU FM Grounds.
   3. Drip Piping – manufactured of polyvinyl chloride compound conforming to ASTM D2241 andASTM D1784, Type 1, Grade 1.
   4. Fittings – Schedule 40 PVC, or as recommended by piping manufacturer.
   5. Drip Valve Assembly:
      a. Wye Strainer – Plastic / Fiberglass construction with 150 mesh nylon screen and blow out assembly. Rainbird
      b. Control Valve – 2-way, solenoid pilot operated type made of synthetic, non- corrosive material; diaphragm-activated and slow closing. Include freely pivoted seat seal; retained (mounted) without attachment to diaphragm. Rainbird EFB-CP or PES.
      c. Pressure Regulator – Plastic / Fiberglass construction, preset type with pressure setting per drawings.
      d. Locator tape shall be wrapped on all risers for emitters and bubblers.

U. Quick Coupling Valves:
   1. Brass two-piece body designed for working pressure of 150 psi, operable with quick coupler.
   2. Equip quick coupler with locking rubber cover (purple for non-potable water if specified).

V. Valve Boxes:
   1. Valve box color to be tan if located in areas of decomposed granite and green if in turf. All box covers for non-potable water systems shall be purple colored, and marked for reclaimed water.
   2. Drip Line Blow-out Stubs, and Wire Stub Box – Carson #910-12.
   3. 1-inch through 2-inch Control Valves – Carson #1419-13B.
   4. Drip Valve Assemblies – Carson #1419-13B.
   5. Control Wiring Splices – Carson #910-12.
   6. Main Line Ball Valves – Carson #910-12.
   7. Air-Relief Valves – Carson #1419-13B.
   8. Manual Drain Valves – Carson #1419-13B.
   9. Emitter Box – NDS 107BC.

W. Low Voltage Electrical Control Wiring:
   1. Electrical Control Wire – AWG UF UL approved No. 14 gauge direct- burial copper wire forall

control wires, and No. 14 gauge direct-burial copper wire for all common wires.

2. Wire Colors:
   a. Control Wires – Red.
   b. Common Wires – White.
   c. Master Valve Wires – Black and Black.
   d. Flow Sensor Wires – Blue and Yellow.
   e. Spare/Future Wires – Green, labeled at termination.
3. Provide two (2) spare/future wires per mainline and/or mainline branch.

X. If multiple controllers are utilized, and wire paths of different controllers cross each other, both common and control wires from each controller shall be different colors.

Y. Wire connections for all valve and solenoid locations shall be UL 486D approved direct-burywire connectors for wet/damp locations, as manufactured by Suresplice, Rainbird DBConnector, or approved equal.

Z. Sprinkler Heads:
   1. Pop-Up – Hunter MP Rotator.
   2. Rotors – Areas larger than 30' wide use Rainbird 5000 or Rainbird Falcon.

AA. Contractor is responsible for all blue staking before and during the project. Request horizontal and vertical location staking from the proper utility companies (including Arizona State University Facilities Management where applicable) for all underground utilities. Take all precautions necessary to protect underground lines from damage. Contractor will repair and pay for any lines damaged during construction.

BB. Preserve and protect all existing trees, plants, monuments, structures, and paved areas from damagedue to work in this section. Any damage shall be completely repaired or replaced to the satisfactionof the Owner. All costs for repair and/or replacement shall be paid for by the Contractor. Restore disturbed areas to original condition, or as approved by the ASU Project Manager.

CC. Prior to the start of any work, the contractor shall walk the project area with ASU FM Grounds staff to identify and understand existing irrigation equipment and system configuration including piping, valves, controllers, point-of-connection(s) and watering zones.

DD. The contractor shall immediately stop work if any unknown irrigation conditions or equipment is encountered during construction, do not connect to or remove any unknown irrigation components without direction and approval by the ASU Project Manager and ASU FM Grounds Representative.

EE. Irrigation Piping and Wiring Installation:
   1. Install sleeving under all asphalt paving and concrete walks, prior to the installation of concrete or paving operations, to accommodate piping and wiring.
   2. Boring will be permitted only where pipe must pass under obstruction(s) which cannot be removed, and must be approved by ASU Project Manager if not specifically indicated on construction drawings.
   3. All trenching or other Work under limb spread of any and all low branching trees and plant material shall be done by hand or by other methods so as to prevent damage to limbs or branches. Prior to commencement of work, Contractor shall obtain approval for trenching methods from the Project Design Professional.
   4. Line clearance – provide not less than 6 inches of clearance between each line, and not less than 12 inches of clearance between lines of other trades.
   5. Pipe and Wire Depth:
      a. Pressure Supply Piping – 24 inches from the top of pipe (30 inches where 6"and larger pipe is on project).
      b. Non-pressure piping – 12 inches from top of the pipe.
      c. Control Wiring – Side and bottom of pressure supply line.
      d. Drip Piping – 12 inches from the top of pipe.

      e. Emitter tubing – 12 inches from top of pipe (non- slope plantings). 4 inches from the top of pipe (slopes 2:1 of greater).

6. When communication cable is not located in the mainline trench it shall be installed one (1) inch DB120 PVC conduit.
7. Provide detectable warning tape for all non-metallic irrigation mainline, utility pipes, conduitor other underground services outside of building line.
8. **Notify ASU FM Grounds for inspection of piping and valve installation prior to backfill operations.**

FF. **Contractor to complete Checklist for Irrigation Substantial Completion and submit to ASU Project Manager prior to scheduling of walk-through.**

GG. Contractor to provide data controller information for each automatic controller installed. Refer to Field Data Controller Chart.

HH. Field data controller chart shall be completed and approved by Project Design Professional prior to Substantial Completion walk-through.

1. Approved controller chart to be attached inside of each controller cabinet.
2. Provide a second copy to ASU FM Grounds representative.

II. Contractor to provide a paper copy of As-Built drawings at Substantial Completion walk-through. Contractor is also responsible for providing corrected digital irrigation As-Built drawings in PDF format(*.pdf). The files will be entered into the campus infrastructure database. Contractor shall submit thedigital As-Built information to ASU Project Manager and Project Design Professional upon project Final Acceptance.

JJ. The maintenance period for all irrigation work shall be based on the following:

- Restoration/repair of an existing system – to date of substantial completion or as directed by Project Manager.
- Select component upgrade – to date of substantial completion or as directed by Project Manager.
- Construction/installation of a new irrigation system – 90 days from the date of landscape and irrigation substantial completion.

KK. For new installations, Contractor shall be responsible for the operation of the irrigation system during the entirety of plant maintenance period or until hand-over to ASU FM Grounds.

1. Within the last 30 days of the maintenance period, the Contractor shall familiarize ASU FDM Grounds staff with the setup and operation of the irrigation system components including, but not limited to the point-of-connection, automatic controller, valves, sprinklers, quick-couplers, sensors, hand-held remote controls, field adjustments and fine-tuning requirements.

LL. For plant establishment period, the Contractor shall advise ASU FM Grounds of controller run-time schedule(s). Contractor to monitor moisture levels during establishment period and recommend when it is appropriate to switch to a regular watering schedule. Contractor to coordinate with ASU FM Grounds on run-time schedule.

MM. Contractor shall warrant materials against defects for a period of one year from the date of Substantial Completion. Contractor shall guarantee workmanship for similar period. Contractor shall be responsible for coordinating material warranty items with the supplier, manufacturer and/or distributor as required. Contractor shall repair any backfilled trenches that settle during the guaranty period at no expense to the Owner, including complete restoration of damaged property.

NN. Contractor to provide Owners Operations and Maintenance Manual to ASU Project Manager upon acceptance of Substantial Completion. Refer to Landscape and Irrigation Owners Operation and Maintenance Manual. Documentation to include the following:

1. Index sheet stating project name, and listing Contractor name, address, phone number, andcontact person. Include same information for Primary Subcontractors.

2. List of major suppliers indicating contact information, materials and/or equipment supplied.
3. Certificate of inspections (as applicable).
4. Manufacturer cut sheets for all material components. Highlight specific models or items.
5. Warranty/Guarantee documents for all materials, equipment and systems used.
6. Letter of Warranty/Guarantee of workmanship.
7. List of spare parts, extra materials and tools supplied to the Owner.
8. Operations instructions including complete description of operations, control diagrams,instructions books for all irrigation components.
9. Maintenance instructions including a written list of required and recommended maintenancefor all irrigation components.

OO. Contractor to furnish the following maintenance tools to the ASU Project Manager uponacceptance of Substantial Completion:

1. Two (2) sets of special tools required for moving, disassembling, and adjusting each type of sprinkler head and valve supplied on this project.
2. Two (2) keys for each automatic controller.
3. Three (3) quick coupler keys and matching hose swivels.

CHECKLIST FOR IRRIGATION SUBSTANTIAL COMPLETION
Page 1

1. ASU will review the following items during the Substantial Completion Walk-Through.
2. The Contractor shall ensure that each item is in satisfactory condition at time of Substantial Completion Walk-Through.
3. The Contractor shall review each item and check the box or note as N/A if not applicable to the project.
4. Submit completed checklist to Project Design Professional for verification PRIOR TO arranging for the Substantial Completion Walk-Through.
5. This guideline is for the Contractors use and does not relieve the Contractor from the contractual obligations or scope of work as defined by the specifications and drawings.

PROJECT / PHASE:____

A. Dedicated Point of Connection
____ Backflow Preventer installed
____ BFP testing complete
____ Backflow Preventer metal security enclosure installed with keyed lock
____ Master Valve and Flow Sensor installed and wired to Controller

B. Valve Box Assemblies
____ Wiring coiled
____ Pin-Tite Connectors installed
____ Correct wire colors, labeled
____ Valve Box installed level to grade, with gravel and filter fabric per detail
____ All Components installed (Ball Valve, Wye Strainer, Pressure Regulator, Union)
____ Jumbo Valve Box w/embossed valve number on lid
____ Christy Tag installed inside valve box with valve number
____ Security Bolt installed on locking valve box lid

C. Emitters / Bubblers
____ Installed per detail, quantity per plant and plant size
____ Locator tape applied to riser
____ Emitter tubing buried 8” minimum below finish grade
____ Daylight emitter tubing vertical, 1” maximum above finish grade
____ Uphill of planting in sloping condition
____ Distribution tubing length 10’-0” maximum to plant served
____ Drip irrigation in Annual Beds, Planter Pots
____ Adjustable bubblers and inspection tubes at palms installed per detail
____ All emitters and/or bubblers operational

CHECKLIST FOR IRRIGATION SUBSTANTIAL COMPLETION

Page 2

D. Sprinklers

____ Correct nozzles installed

____ Full head-to-head coverage

____ Adjust sprinklers to eliminate over-spray of walls, structures and adjacent hardscape/walks

____ Flow control of valve throttled

____ Heads flush with grade

____ Heads set 6” away from of walls, structures and adjacent hardscape/walks

E. Flush caps installed at the end of each poly-line run

F. Quick couplers installed

G. Check valves installed when elevation differential exceeds 10'

H. Spare control wires installed and labelled

I. Automatic Controller

____ Satellite Controller installed per manufacturer’s specifications

____ Power supplied with separate circuit and breaker, identified at panel

____ Grounding installed

____ Controller Cabinet keys provided to Owner

____ Completed and approved Field Data Controller Chart

____ Irrigation As-Built drawings (paper copy) completed for walk-though

CHECKLIST SUBMITTED BY:

General Contractor: ______________________________________ Date: ____________________

Landscape Contractor: ______________________________________ Date: _____________________

Project Design Professional: ______________________________________ Date: _____________________

Arizona State University

LANDSCAPE AND IRRIGATION
OWNERS OPERATION AND MAINTENANCE MANUAL

TABLE OF CONTENTS

Arizona State University

FINAL ACCEPTANCE SHEET

The ASU Project Manager will be responsible for coordinating walk-throughs, recording dates and securing approval signatures from all reviewers. The Contractor shall insure that the date for seed application has been recorded.

PROJECT / PHASE:____

A. Landscape, Hardscape, Irrigation Walk-through for Substantial Completion **Date:**__________
Start of 90 Day Maintenance and 1 Year Guarantee Period

B. Seeding application, if applicable (by Contractor) Date:__________

C. Verification of Landscape, Hardscape, Irrigation Punch Lists;
Notice of Landscape, Irrigation Final Acceptance **Date:**__________
(Within 14 days of date of Substantial Completion)

D. Final hardscape, landscape and irrigation as-built information accepted Date:__________

E. 30 Day Landscape, Hardscape, Irrigation Review **Date:**__________

F. 60 Day Landscape, Hardscape, Irrigation Review **Date:**__________

G. Owner Training, if applicable Date:__________
(Within 30 days of end of maintenance period)

H. End of 90 Day Maintenance Period **Date:**__________

I. Guarantee Period Walk-through – Shrubs, Groundcover **Date:**__________
(90 Days from Date of Substantial Completion)

J. Verification of walkthrough punch list – Shrubs, Groundcover Date:__________

K. Guarantee Period Walk-through – Hardscape, Trees, Irrigation **Date:**__________ (1
Year from Date of Substantial Completion)

L. Verification of walkthrough punch list – Hardscape, Trees, Irrigation Date:__________

M. Notice of Guarantee Period Completion Date:__________

PROJECT REVIEWED AND ACCEPTED BY:

ASU Project Manager: ____

FDM Grounds Representative: ____

Project Design Professional: ____

General Contractor: ____

Landscape Contractor: ____

FIELD DATA CONTROLLER CHART

Controller No. __________ **Location:** ________________________________ **Master Valve Size:** ___________ **Flow Sensor Size:** ___________

Station #	Valve Size	Output Type (spray/rotor/ bubbler/drip)	Arc	Station Flow (GPM)	Precip. Rate (in./hr.)	Station Description	Notes
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							
13							
14							
15							
16							
17							
18							
19							
20							
21							
22							
23							
24							
25							
26							
27							
28							
29							
30							
31							
32							
33							
34							
35							
36							
37							
38							
39							
40							
41							
42							
43							
44							
45							
46							
47							
48							

32 90 00 - Landscaping

Description

The intent of this section is to provide a general scope for all landscape development for campuses within the ASU system. These are broad enough to allow for modification by the Design Professional (DP) if the project calls for specific installation requirements that are not addressed herein.

Design Standard

General

A. All planting material for new and renovation projects are limited to the selection of materials outlined below or approved by OUA, and should be scaled, located and/or placed in a manner that both supports and furthers the project's overall 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. Where possible all existing plant material should be noted and catalogued for potential salvage operations. In coordination with the project team, it will be the determination of the ASU staff (Grounds and OUA) which plantings will be transplanted, stored on site, or destroyed.

B. A list of plant material has been vetted with the ASU FM Grounds team and will act as the baseline for all site development work at Arizona State University. Considerations will be made if additional materials are appropriate to use in site specific locations. This list was developed to highlight native and desert adapted species and reduce/eliminate the use of IUCN-listed invasive alien species. Please note that this list is in response to the climatic concerns and conditions of the University facilities and regional context.

C. The DP's schematic landscape plan shall clearly indicate the species, 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 required. A copy of the design development landscape design plan should be submitted to ASU Grounds for review and comment **prior to construction documentation completion.** These plans shall indicate number and size, irrigation mainlines and points of connection.

D. 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. This will include the initial placement adjacent to walks and buildings. Plantings shall not be closer than **32” from center of new plant to edge of walk**.

E. The approximate life expectancy of plant material in a healthy visual state should be considered in selection.

F. The planting density for all new projects shall be 1 plant per 20 SF – average - over the entire planting area. In consultation with OUA, plant densities may be increased or decreased based on project intent and location.

Lawns

A. Lawn grass shall not be used in areas that cannot be **actively programmed** for use by students and staff. Lawn shall only of a usable size, fully accessible and maintainable for irrigation, mowing, fertilizing and pest control.

B. Lawns shall be established by cut sod or stolons. In either case, the soil shall be thoroughly roto-tilled to a depth of 6” and leveled to receive grass. For sod, soil shall be 1/2 inch lower than existing grass, to ensure new sod is level with existing grass.

C. 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 perennial Rye grass. Installation of sod will be coordinated with seasonal factors. Newly planted sod shall not be overseeded in the first year of growth unless otherwise approved by ASU. Overseeded sod is permissible based on seasonal requirements.

D. Sod installation in fall or winter will be overseeded at the farm, and fully established, prior to cutting and transportation to site.

Trees and Shrubs

A. 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); or low breaking specimens. The “face” of the tree will be oriented parallel to the walkway and will allow for the tree to grow without impeding the walkway.

B. Trees in lawn areas shall have tree guards acceptable to ASU FM Grounds.

C. Plants that encourage pests or rodents are highly discouraged. The use of citrus plant material will only be allowed in areas approved by ASU FM Grounds and OUA.

D. ASU will review and inspect plants proposed for use on campus and reserves the right to refuse specific plants that they find unacceptable. Root bound trees are **not acceptable and will be rejected**. The DP and Contractor shall review at the nursery prior to delivery to the job site.

E. All plants shall be types proven to be hardy for the area and situation, including micro-climates developed by the building and adjacent structures and mature plant materials.

F. The use of 15 gallon trees is discouraged in mature landscape areas, but can be considered for back-of-house installations or under special conditions as approved by ASU FM Grounds and the Office of the University Architect (OUA).

G. Minimum caliper sizes for new trees shall be per Arizona Nursery Association standards for box size.

H. Minimum box tree size shall be 24 inches for non-specimens and 36 inch for specimens (or larger in key areas).

I. Trees in lawn areas shall be provided with 24 inches of bare, sod-free soil beyond and around the full circle of the tree. The root crow shall never be buried and shall be 1 inch above grade. Temporary berms for initial water are acceptable, depending on site conditions and will be removed by the contractor at the end of the maintenance period.

J. The use of desert trees planted in turf areas is discouraged.

K. Trees selected for planting in an Arboretum designated display or collection area shall be reviewed and approved by OUA

L. 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 sidewalks.

M. Insure tree locations do not conflict with pedestrian and/or street light poles at full maturity.

N. All trees and shrubs shall be planted in holes dug to specifications recommended by the Arizona Nurseryman's Association and the University of Arizona Cooperative Extension Service.

O. All palms shall have a 6” perforated, capped and wrapped, Schedule 40 PVC inspection tube that extends to the depth of the planting pit.

P. All trees 36” box and larger will NOT be staked at the time of planting. ALL nursery stakes are to be removed prior to the contractor leaving the site, unless otherwise noted by and approved by ASU FM Grounds. ALL staking will be placed outside of the plant pits for stability. Contractor to follow the details of the construction documents.

Q. The use of a modular suspended pavement system (i.e., Silva Cell) is highly encouraged for tree plantings in plaza areas, parking lots and high traffic volume paved mall areas.

R. The use of structural soil is not permitted.

Obstructions

A. Isolated post in lawn areas shall have a concrete mow strip minimum 7 inch around the post.

B. Buildings adjacent to lawn areas, shall have a non-planted area, a minimum of 12 inch in width.

Parking Lots

A. Trees planted in median strips shall be of a type that permits pruning to give a full 8' clearance at curb side. Trees in these areas should have an upright or longitudinal growth habit. The “face” of the tree will be oriented parallel to the parking space.

B. Passive rainwater harvesting in parking lot medians is highly encouraged.

C. Medians shall be planted with a hardy ground cover and decomposed granite top dressing. 3-6” rip rap shall be used at curb inlet openings.

D. The goal is to have trees located in the parking lot and not just at the perimeter to mitigate localized ambient temperature.

Soil Preparation

A. All soil and topsoil 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. Mulch shall be finely ground decomposed pine bark. Mulch to be installed in flower beds or as directed by ASU FM Ground and/or OUA.

d. The use of manure of any kind is NOT permitted.

e. Chemical additives shall be of agricultural grade, used as necessary to maintain a pH at 6.5 to 8.0.

f. Compost additives, where required, shall be purchased from the ASU campus provider. OUA and/or ASU FM Grounds will provide contact data as required.

g. Inorganic fertilizer shall be used as directed by ASU Grounds Services. A certified organic source fertilizer is preferred but not mandatory.

Maintenance

A. 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.

B. Specifications shall require Contractor 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.

C. Specifications and notes on the landscape drawings shall require the contractor to maintain the plant material for a minimum of 90 days after substantial completion of the landscape installation and accept all responsibility for all plant material until final acceptance of the work by ASU (exclusive of replacement under the warranty period).

D. Maintenance schedules shall be submitted to and approved by and kept on file with ASU FM Grounds for the 90 day period prior to final acceptance.

E. Pruning shall be limited to the removal of dead plant material or growth that would harm the overall structure and form of the plant.

F. The as-builts for all planting and irrigation installations shall be submitted to ASU FM Grounds and the ASU Project Manager on the tables and charts included here.

Decomposed Granite

A. Decomposed granite at ASU shall be a 50/50 blend of 1/2-inch and 3/4-inch screened or washed material as approved by OUA.

B. If other decomposed granite is approved for a specific project, then specifications (including description, size, color, samples and suppliers) shall be furnished to OUA and ASU Grounds. Wash areas, bioswales, basins, roof drain outfall points, and desert cobble areas will have an initial cover of 6” – 8” rip rap, tamped into place and then top dressed with 3” minus. All areas then will be water settled. All rip rap and chat will match the adjacent decomposed granite.

C. The decomposed granite colors approved for each campus are as follows:
   a. Tempe – Carmel or approved equal
   b. Polytechnic – Apache Red or approved equal
   c. Downtown Phoenix – Carmel or approved equal
   d. West – Apache Gold or approved equal
   e. Lake Havasu – Aztec Gold or approved equal

D. Samples to be provided for review and approval by OUA and should be of sufficient quantity to determine color compatibility to adjacent sites.

CHECKLIST FOR LANDSCAPE SUBSTANTIAL COMPLETION

Page 1

1. ASU FM Grounds will review the following items during the Substantial Completion Walk-Through.
2. The Contractor shall ensure that each item is addressed and is in satisfactory condition at the time of Substantial Completion Walk-Through.
3. The Contractor shall review each item and check the box or note as N/A if not applicable to the project.
4. Submit completed checklist to Project Design Professional for verification PRIOR TO arranging for the Substantial Completion Walk-Through.
5. This guideline is for the Contractor's use and does not relieve the Contractor from the contractual obligations or scope of work as defined by the specifications and drawings.

PROJECT/PHASE:____

____ Grades (transition to natural areas, proper level at the back of curb, sidewalk or hardscape edges, trench settlement, wash definition, restoration at path or trail interface, restoration from work by others).

____ Drainage problems eliminated (ponding, erosion), maintain existing drainage routes, sub-surface drainage systems installed and tested.

____ Hardscape and/or walkway construction complete: cross slopes, surface drainage, scoring/paving patterns, colors, finishes and textures, cracking and/or settlement corrected.

____ Walls, fencing, columns installed per plan and manufacturer's directions, plumb and level.

____ Utility equipment installation and coordination, painted per specifications.

____ Boulder installation (scars treated with Eonite^{TM} or approved alternate).

____ Trees and specimen plants oriented correctly.

____ Trees and plants set at correct depth (root flare visible).

____ Plumb on Trees, Saguaros, Ocotillos.

____ Tree staking completed per detail, nursery stakes removed.

____ Tree tags on nursery material (remove upon verification).

____ Turf subgrade preparation with correct fine grading, compaction and soil amendments.

____ Sod and/or stolon installation, condition, edging installed, patching(seed/sod).

____ Plants located per plan and installed per details (plant wells, offsets, spacing/density and setbacks).

____ Annual beds installed per plan (correct soil mixture, plant spacing).

____ Palms matched height and appearance, installed plumb, fronds tied until new growth observed.

____ Pots installed and planted per plan, sealed interior, correct soil mixture, irrigation and drainage.

____ Plant material in vigorous, healthy condition.

____ Dead, stressed or missing plants replaced.

CHECKLIST FOR LANDSCAPE SUBSTANTIAL COMPLETION
Page 2

____ Prune out dead wood, broken branch stubs, correct clearances at walkways, site visibility zones and seating areas.

____ Soil rings installed for Trees, Palms in turf.

____ Filter fabric installed where specified, no exposed edges.

____ Decomposed granite areas installed (pre-emergent applications), raked smooth.

____ Desert cobble installed, blended at disturbance line, match existing patterns and densities.

____ Fixed site furnishings installed per manufacturer's directions.

____ Movable site furniture placed or provided by Contractor.

____ Lockable bollard keys provided to ASU Project Manager.

____ Excess granular, cobble, concrete spoils, irrigation materials, litter, and trash removal.

____ No tape, string, wire, etc. left on plant material.

____ Landscape As-Built drawings (paper copy). Check for accuracy, tag number, type – box, spade (for salvage material).

____ Weed control (pre-emergent application) per specifications.

____ Seeding application (If applicable) Date: ____________________

CHECKLIST SUBMITTED BY:

General Contractor: ____ Date: ______________________

Landscape Contractor: ____ Date: ______________________

Project Design Professional:_____________________________________ Date: ______________________

FINAL ACCEPTANCE SHEET

The ASU Project Manager will be responsible for coordinating walk-throughs, recording dates and securing approval signatures from all reviewers. The Contractor shall insure that the date for seed application has been recorded.

PROJECT / PHASE:____

A. Landscape, Hardscape, Irrigation Walk-through for Substantial Completion **Date:**___________
Start of 90 Day Maintenance and 1 Year Guarantee Period

B. Seeding application, if applicable (by Contractor) Date:___________

C. Verification of Landscape, Hardscape, Irrigation Punch Lists;
Notice of Landscape, Irrigation Final Acceptance **Date:**___________
(Within 14 days of date of Substantial Completion)

D. Final hardscape, landscape and irrigation as-built information accepted Date:___________

E. 30 Day Landscape, Hardscape, Irrigation Review **Date:**___________

F. 60 Day Landscape, Hardscape, Irrigation Review **Date:**___________

G. Owner Training, if applicable Date:___________
(Within 30 days of end of maintenance period)

H. End of 90 Day Maintenance Period **Date:**___________

I. Guarantee Period Walk-through – Shrubs, Groundcover **Date:**___________
(90 Days from Date of Substantial Completion)

J. Verification of walkthrough punch list – Shrubs, Groundcover Date:___________

K. Guarantee Period Walk-through – Hardscape, Trees, Irrigation **Date:**___________
(1 Year from Date of Substantial Completion)

L. Verification of walkthrough punch list – Hardscape, Trees, Irrigation Date:___________

M. Notice of Guarantee Period Completion Date:___________

PROJECT REVIEWED AND ACCEPTED BY:

ASU Project Manager: ____

FDM Grounds Representative: ____

Project Design Professional: ____

General Contractor: ____

Landscape Contractor: ____