

AMERICAN UNIVERSITY DESIGN STANDARDS





AMERICAN UNIVERSITY

W A S H I N G T O N, D C

MEMORANDUM

FROM: CURTIS DREW, COMMISSIONING & PROJECT ACCEPTANCE MANAGER,
CAPITAL PROJECT MANAGEMENT

DATE: February 15, 2023

INTRODUCTION

The standards set forth in these documents are intended to serve as design and construction standard guidelines for American University. As such, they reflect the planning, design, construction, and maintenance expertise of University personnel. The standards have been compiled and edited by the Department of Capital Project Management and Facilities Management within the Office of Finance and Treasurer.

As standards for the University, this information is to be applied to renovation and new construction from the very first planning and design stages through actual construction and facilities maintenance and management. The information included within each standard section contains procedures to be followed, materials to be used, or design guidelines that we at American University have found to be appropriate to assure the quality desired at the University now and through our future maintenance of these facilities. Personnel within the University, as well as outside architects, consultants, and contractors should become familiar with these standards.

American University uses its best efforts to promulgate standards for the benefit of those parties involved in providing services to American University in light of available information and accepted industry practices. American University does not guarantee, certify, or assure the safety or performance of any products, components, or systems tested, installed, or operated in accordance with American University standards, or that any tests conducted under its standards will be non-hazardous or free from risk.

SCOPE OF THE STANDARDS

The standards included herein shall serve as a basis for a code of quality for all campus-wide design, construction, and maintenance procedures. The level of quality deemed by any one standard is determined on the basis of reliability, serviceability, safety, and cost (including design, construction,

inventory, operating, and maintenance costs). The information contained in these standards is not specific to any one project, but common to all projects. As the University constructs a wide range of facilities, these standards must be adjusted to meet specific project needs. These standards establish a baseline of quality and it is American University's expectation that deviations from these standards will be discussed with the University throughout the design process. If the designer does not bring forward suggested deviations from the Design and Construction Standards, drawings will be reviewed for conformance.

STANDARDS VERSUS SPECIFICATIONS

Standards shall form the basis from which to create specifications. All of the concepts and procedures included are for the use of designers and consultants. The use and inclusion of these standards in bid documents does not relieve the consultant or architect of the responsibility and legal liability for any bid documents created from these standards.

A DYNAMIC DOCUMENT

Standards from all areas of design and construction are continually being developed. As changes and new sections are ready for inclusion, changes shall be made. This document will never be published but remains a "living" document keeping abreast of new and better procedures or materials as we become aware of them.

AVAILABILITY

These standards were developed and are maintained by the Department of Capital Project Management, Osborn Building, American University, Washington, DC 20016.



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Individual pdf versions of the contents are located in the tabbed sections at www.american.edu/standards.

Archived Documents (prior versions of the AU Design and Construction Standards) and the Standards Change Request form are available in the tabbed sections of the main web page www.american.edu/standards.



American University Design Standards Committee

The American University Design (AUDS) Committee is a multidisciplinary body of staff established to promulgate guidelines that communicate AU’s requirements to persons who perform, manage, or coordinate work for the university. The Committee meets monthly to process recommendations for addition or deletion of acceptable products.

Access the latest approved version of the American University Design Standards at www.american.edu/standards.

Design Standards Committee Members - 2023

Name	Department Title
Juan Allen	Facilities Management Energy Conservation & Efficiency Manager
Carl Spence	Facilities Management Electrical and Life Safety Manager/Master Electrician
Eddy Peng	Facilities Management Building Automation Supervisor
David Osborne	Facilities Management Director, Energy and Engineering
Curtis Drew (Meeting Chair)	Facilities Management Commissioning & Project Acceptance Manager
Joseph van Story	Facilities Management Director Facilities Management
Tony Cortes	Facilities Management Director Capital Project Management
Mark Freeman	Facilities Management Central Plant Chief Engineer
Jonathan McCann	Assistant Vice President Planning & Project Management



Preface

The American University provides the Design Standards, a guide for Consultants, to assist in meeting the expectations of the University for professional design and construction services. It is our intention that this publication assists with your efforts and better enables you to be responsive to our needs and to fulfill our mission and achieve our goals.

The American University Design standards are for your benefit and ours, to clarify expectations for design and construction services. Although we believe it is comprehensive in scope, we do not claim that it covers every aspect of the professional services required or as elaborated in the engagement agreement.

These guidelines do not change your professional and legal responsibility to provide to American University with the highest quality design for the project. Please feel free at any time to contact us concerning this guideline as the University wants to ensure that communication is clear and that you are able to fulfill your duties.



Forward

This publication was prepared for the guidance of Consultants providing architectural and engineering services under contract to the American University (AU). The American University Design Standards (AUCS) was developed with input from key stake holders including, Facilities Management (FM), Planning and Project Management (PPM), Office of Information Technology (OIT), Office of Sustainability (OS), Auxiliary Services (AS), University Safety and Security Services (USSS), Housing & Residence Life and Purchasing.

Consultants will use the AUDS for all new construction and renovation projects. The designated AU project manager may request, in writing, additions or exceptions to the technical standards for approval by AU's design standards committee. The committee will consider only fully developed technical submissions with performance and financial justifications.

A firm or individual providing consulting services to the American University will be the Designer of Record and will incur the usual professional responsibilities and liabilities for the specific project. The Consultant should be familiar with the contract terms and content of this publication with respect to sustainable pre- construction, construction, and post-construction design responsibilities.

American University updates the document as necessary to reflect any required changes to the technical standards and specifications. It is the user's responsibility to ensure that he/she is working from the most current update. The most current version is available on the Facilities Management Website, which links to www.american.edu/standards. The University archives previous versions. Contractually, "the most current version" is the revision in effect on the Facilities Management Website when the design or consulting contract "Notice to Proceed" is given.



AMERICAN UNIVERSITY
DESIGN STANDARDS
CONSULTANT GUIDE

CONSULTANT GUIDE

GENERAL

MASTER PLANNING

American University undergoes a rigorous strategic planning process to match strategies, programs and facility improvements to the mission of the University. Consultants should avail themselves of information about current initiatives and campaigns during the design process. Campus information is available at the main university website www.american.edu.

A listing of departmental contacts to request information on current Master Plans pertinent to design and construction is available on the website at American University Design and construction website at www.american.edu/standards. Direct specific questions about university master plan requirements to Planning and Project Management or the assigned Project Manager.

UTILITIES AND SYSTEMS

Master planning is essential to the long-term reliability, operability, flexibility and efficiency of our systems. Facilities Management has developed a utilities master plan committed to district heating and cooling whenever practical. Consultants shall work with Facilities Management to become familiar with these and other departmental campus plans.

Energy conservation and efficiency of mechanical and electrical systems is critically important to the university. A strategic objective for designs is supporting Energy Star ratings for our systems and facilities. The Consultant should not base design equipment/system selections solely on Energy Star or initial cost.

The Consultant may prepare a Life Cycle Cost Analysis (LCCA) in the early design stages and present the LCCA to the Project Manager and Director of Energy and Engineering for review and/ or approval. The university defines LCCA as the total cost to operate and maintain a piece of equipment, product or system over its useful life, including the cost of procurement. Additionally, high-energy system equipment such as HVAC chillers and pumping systems, require a Present Worth Analysis (PWA) over the projected life cycle. Both types of studies shall consider the time value of money and discount all future cash flows to present.

DESIGN QUALITY

At American University (AU), each project has its own unique, programmatic and contextual requirements. The Consultant shall take into consideration the location of the project and shall design with a full understanding of the unique surroundings. All design elements must be carefully explored with long-term goals in mind (projected life of facility, equipment, and systems).

New facilities will be designed with a minimum rating of LEED® Gold. Existing facilities



will establish LEED® ratings targeting the same as practical, based on the current condition and the extent of renovation required. Energy Star rating will also be evaluated.

American University requires that the Consultant adhere to the latest edition of the AU Design and Construction Standards. The latest version of the AU Design and Construction Standards, which includes this Design Consultants Guide, is available at the website www.american.edu/standards.

Exceptions may be made on a case-by-case basis by requesting approval in writing from the Design Standards Committee (Chaired by Facilities Management's Director of Energy & Engineering). The University's Project Manager must maintain documentation for any exceptions.

The Consultant is expected to explore and present options toward making a recommendation for a design solution. There are no pre-established design styles or solutions for any project. Additional information applicable to design development of the project general requirements and construction documents is on the web site above under the CSI Divisions tab.

A detailed comparison and lifecycle economic analysis between various design options should be prepared where appropriate. Their use in determining the design solution shall be coordinated with AU's project manager and key stakeholders from the operations team. Design concepts shall incorporate the latest available technology wherever possible including the LEED® rating system.

DESIGN PROCESS

The design team shall establish and submit to the university's project manager a schedule identifying specific milestones, approval requirements, and the time necessary, after the project is approved, for design and/ or construction. The design team shall coordinate proposed projects with appropriate university reviewers, officers or departments to receive approval to continue. The Consultant shall prepare appropriate presentation materials to convey the design concepts at each phase.

AESTHETIC CONSIDERATIONS

The Consultant shall become knowledgeable with sustainable planning principles that have been established for the American University campus. This information is contained in the following documents (available as appropriate via AU's project manager):

- Campus Plan 2021
- Zoning Order approving the Campus Plan
- Related planning documents from the university where appropriate

The following general design principles have evolved over the years at the university:

- On or near the Freidheim Quadrangle, enhancement rather than dramatic



departure from existing design is highly preferred.

- When selecting exterior building materials, approvals from the University's Project Management must be secured prior to proceeding with further design development.
- Provision for future expansion should include flexibility for institutional programming changes and departmental master plan implementation.
- The American University campus is a certified arboretum. Each project shall be designed with limited tree removal and impact on traditionally forested areas.

UNIVERSITY RESPONSIBILITIES

American University's project manager may provide the following information or services:

1. Scope for design services
2. Project budget and schedule
3. Drawings of existing facilities and information pertinent to building services and utilities
4. American University Design and Construction Standards
5. Coordination of drawings distributed for in-house reviews
6. Coordination of in-house reviews
7. Coordination of user/occupant reviews
8. Coordination of interior design-related needs
9. Coordination of user/occupant moves
10. Coordination of university approval and/or committee reviews
11. Building information access for all design phases
12. Access to existing building systems archive (blueprints, specifications, etc.)
13. Information on commissioning requirements and responsibilities

DESIGN SUBMITTALS

The Consultant shall develop for the university's project management and maintenance units' review and approval schematic design, design development and construction documents unless otherwise noted in the design RFP.

Documents shall establish the scope, relationship, forms, size and appearance of the project in accordance with the requirements of all Agreements.

Pre-design, programming and feasibility studies are not required, unless specifically requested by the university's project management.

The Consultant shall provide design calculations for review upon request. A tabulation of gross, net, and assignable square foot building areas shall be submitted with each design phase and shall follow FICM (Facilities Inventory and Classification Manual) methodology. The latest edition of the American University Design and Construction Standards shall be



used by the Consultant throughout the design process. Use of this document does not relieve the Designer of Record of the responsibility for the final design in accordance with the Project Agreement and with professional standards of practice.

Design submittals to the university's Project Manager at each phase of design shall consist of multiple sets of drawings and specifications (including electronic copies).

The Consultant shall submit design schedules to AU's project manager. When projects involve interruptions of existing building operations or major utility usage, the Consultant shall be responsible for discussing the required outages and service interruptions with Facilities Management during each phase of the design. The Consultant will establish schedule requirements for these interruptions that may adversely affect campus services or ongoing operations. A brief description of the restrictions and their basis is required.

Schematic Design - Shall include architectural plans of each floor, including those below grade, all elevations, and typical building section and preliminary analysis and evaluation of LEED® criteria.

Design Development - Participation in or development of and verification with project team of the Owner's Project Requirements and specifications outline as required by the RFP or design contract. The specifications in this phase shall identify all significant architectural, mechanical and electrical materials and equipment in CSI format and how it conforms to the LEED criteria being sought for the project.

Construction Drawings (100%) - Shall reflect an expansion of the schematic design phase and shall establish the final scope, form and size of the project.

EQUIPMENT PROCUREMENT

The university may elect to purchase equipment directly for some projects and will, in such cases, require the Consultant to assist in the preparation of equipment bid documents and bidding. The university's Project Manager will coordinate the equipment procurement and delivery schedule.

CONSTRUCTION AND CLOSE-OUT PHASES

After completion of punch-list items by the Contractor, the Consultant shall submit a report of field verification and status of items. This status report will be updated at regular intervals until all punch-list items are resolved to the university's satisfaction.

Review operating and maintenance manuals submitted by the Contractor for completeness. These manuals shall include all pertinent information to successfully operate and maintain all equipment related to the project



SUBSTITUTION PROCEDURES

ACTION SUBMITTALS

- A. Substitution Requests: Submit electronically each request for consideration. Identify product or fabrication or installation method to be replaced. Include Specification Section number, title, and Drawing numbers and titles.
 1. Substitution Request Form: Use form attached at end of this Section.
 2. Documentation: Show compliance with requirements for substitutions and the following, as applicable:
 - a. Statement indicating why specified product or fabrication, or installation cannot be provided, if applicable.
 - b. Coordination information, including a list of changes or revisions needed for other parts of the Work and to construction performed by Owner and separate contractors that will be necessary to accommodate proposed substitution.
 - c. Detailed comparison of significant qualities of proposed substitution with those of the Work specified. Include annotated copy of applicable Specification Section. Significant qualities may include attributes such as performance, weight, size, durability, visual effect, sustainable design characteristics, warranties, and specific features and requirements indicated. Indicate deviations, if any, from the Work specified.
 - d. Product Data, including drawings and descriptions of products and fabrication and installation procedures.
 - e. Samples, where applicable or requested.
 - f. Certificates and qualification data, where applicable or requested.
 - g. Material test reports from a qualified testing agency indicating and interpreting test results for compliance with requirements indicated.
 - h. Detailed comparison of Contractor's construction schedule using proposed substitution with products specified for the Work, including effect on the overall Contract Time. If specified product or method of construction cannot be provided within the Contract Time, include letter from manufacturer, on manufacturer's letterhead, stating date of receipt of purchase order, lack of availability, or delays in delivery.
 - i. Cost information, including a proposal of change, if any, in the Contract Sum.
 - j. Contractor's certification that proposed substitution complies with requirements in the Contract Documents except as indicated in substitution request, is compatible with related materials, and is appropriate for applications indicated.
 - k. Contractor's waiver of rights to additional payment or time that may subsequently become necessary because of failure of proposed substitution to produce indicated results.
 3. Architect's Action: If necessary, Architect will request additional information or documentation for evaluation within 7 days of receipt of a request for



substitution. Architect will notify Contractor of acceptance or rejection of proposed substitution within 15 days of receipt of request, or 7 days of receipt of additional information or documentation, whichever is later.

- a. Forms of Acceptance: Change Order, Construction Change Directive, or Architect's Supplemental Instructions for minor changes in the Work.
- b. Use product specified if Architect does not issue a decision on use of a proposed substitution within time allocated.

SUBSTITUTIONS

- A. Substitutions for Cause: Submit requests for substitution immediately on discovery of need for change, but not later than 15 days prior to time required for preparation and review of related submittals.
 1. Conditions: Architect will consider Contractor's request for substitution when the following conditions are satisfied. If the following conditions are not satisfied, Architect will return requests without action, except to record noncompliance with these requirements:
 - a. Requested substitution is compatible with other portions of the Work.
 - b. Requested substitution has been coordinated with other portions of the Work.
 - c. Requested substitution provides specified warranty.
 - d. If requested substitution involves more than one contractor, requested substitution has been coordinated with other portions of the Work, is uniform and consistent, is compatible with other products, and is acceptable to all contractors involved.



REQUEST FOR SUBSTITUTION FORM

1. Date: _____ Request No: _____
2. Project Name: American University, Project Name.
3. Specification Reference: _____
4. Description of specified product or system: _____
5. Trade name, model number, and name of proposed substitution:
(List Original and Proposed information)

6. What effect does substitution have on applicable code requirements?

7. Differences between proposed substitution and specified item? (Use attachment for additional space, if required.)

8. Manufacturer's warranty on proposed and specified items are:
Same Different
(Explain on attachment.)
9. Reason for requesting substitution:
Cause Convenience

10. Monetary considerations:
Specified Product \$ _____
Proposed Substitution: \$ _____
11. Undersigned shall pay for changes to the building design, including engineering and detailing costs, caused by the requested substitution .
12. Enclosed data consists of:
Catalog Drawings Samples Tests Reports
13. List local vendors and supplier representatives:

14. List availability of maintenance service and replacement materials.

14. State effects of substitution on construction schedule and changes required in other work or product:



15. State effects of substitution on project sustainability goals:

16. Any license fees or royalties: Yes No

UNDERSIGNED certifies:

- \$ Proposed substitution has been fully investigated and determined to be equal or superior in all respects to specified product.
- \$ Same warranty will be furnished for proposed substitution as for specified product.
- \$ Same maintenance service and source of replacement parts as applicable is available.
- \$ Proposed Substitution will not affect or delay Progress Schedule.
- \$ Cost data as stated above is complete. Claims for additional costs related to accepted substitution that may subsequently become apparent are to be waived by the Contractor.
- \$ Proposed substitution does not affect dimensions or functional clearances.
- \$ Payment will be made for changes to building design, including architectural or engineering design, detailing, and construction costs caused by proposed substitution.
- \$ Coordination, installation, and changes to the Work as necessary for accepted substitution will be complete in all respects.

Submitted by:

For use by Architect:

Signature _____

Accepted: Accepted as Noted:

Firm _____

Not Accepted: Received Too Late: Date _____

Address _____

Date _____

Remarks: _____

Telephone _____

Approved by (C.M.)

By: _____

LIST OF ATTACHMENTS:

END OF FORM



PROJECT MANAGEMENT AND COORDINATION

GENERAL

DIGITAL PROJECT MANAGEMENT PROCEDURES

Web-Based Project Software: Use Contractor's web-based Project software site (Procore) for purposes of hosting and managing Project communication and documentation until Final Completion at which time all digital data shall become property of the Owner.

SUBMITTAL PROCEDURES

GENERAL

SUBMITTAL SCHEDULE

- A. Submittal Schedule: Submit, as an action submittal, a list of submittals, arranged in chronological order by dates required by construction schedule. Include time required for review, ordering, manufacturing, fabrication, and delivery when establishing dates. Include additional time required for making corrections or revisions to submittals noted by Architect and additional time for handling and reviewing submittals required by those corrections.
 1. Coordinate submittal schedule with list of subcontracts, the schedule of values, and Contractor's construction schedule.
 2. Initial Submittal: Submit concurrently with startup construction schedule. Include submittals required during the first 14 days of construction. List those submittals required to maintain orderly progress of the Work and those required early because of long lead-time for manufacture or fabrication.
 3. Final Submittal: Submit concurrently with the first complete submittal of Contractor's construction schedule.
 - a. Submit revised submittal schedule to reflect changes in current status and timing for submittals.
- B. Product Schedule: As required in individual Specification Sections, prepare a written summary indicating types of products required for the Work and their intended location. Include the following information in tabular form:
 1. Type of product. Include unique identifier for each product indicated in the Contract Documents or assigned by Contractor if none is indicated.
 2. Manufacturer and product name, and model number if applicable.
 3. Number and name of room or space.
 4. Location within room or space.
 5. Submit product schedule in the following format:
 - a. PDF electronic file.



QUALITY REQUIREMENTS

GENERAL

CONTRACTOR'S QUALITY-CONTROL PLAN

- A. Quality-Control Plan, General: The Architect & Design Engineer shall initiate discussion between the Owner and the Design Team to codify the Contractor's Quality Control oversight requirements during the project's construction phase. During these QC efforts and in most cases, the Contractor's QC Manager can also act as site superintendent. This is also left to the discretion of the Owner and the Design Team.

QUALITY CONTROL

- A. Contractor Responsibilities: Tests and inspections not explicitly assigned to Owner are Contractor's responsibility. Perform additional quality-control activities required to verify that the Work complies with requirements, whether specified or not.
 - 1. Unless otherwise indicated, provide quality-control services specified and those required by authorities having jurisdiction. Perform additional quality-control activities, whether specified or not, to verify and document that the Work complies with requirements.
 - 2. Engage a qualified testing agency to perform these quality-control services.
 - 3. Notify testing agencies at least 24 hours in advance of time when Work that requires testing or inspecting will be performed.
 - 4. Where quality-control services are indicated as Contractor's responsibility, submit a certified report of each quality-control service.
 - 5. Testing and inspecting requested by the Contractor and not required by the Contract Documents are Contractor's responsibility.
- B. 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.
- C. Testing Agency Responsibilities: Cooperate with Architect, Commissioning Authority and Contractor in performance of duties. Provide qualified personnel to perform required tests and inspections.
 - 1. Notify Architect, Commissioning Authority and Contractor promptly of irregularities or deficiencies observed in the Work during performance of its services.
 - 2. Determine the location from which test samples will be taken and in which situations 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 report 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 any duties of Contractor.
- D. **Manufacturer's Field Services:** Where indicated, engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including service connections.
- E. **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 report.
- F. **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.
- G. **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's quality-control plan. Coordinate and submit concurrently with the Contractor's construction schedule. Update as the Work progresses.
1. **Distribution:** Distribute schedule to Owner, Architect, Commissioning Authority, testing agencies, and each party involved in performance of portions of the Work where tests and inspections are required.

TEMPORARY FACILITIES AND CONTROLS

GENERAL

USE CHARGES

- A. **General:** Installation and removal of and use charges for temporary facilities shall be included in the Contract Sum unless otherwise indicated. Allow other entities engaged in the Project to use temporary services and facilities without cost, including, but not limited to Architect, testing agencies, and authorities having jurisdiction.
- B. **Sewer Service:** Owner will pay sewer-service use charges for sewer usage by all entities for construction operations.
- C. **Water Service:** Owner will pay water-service use charges for water used by all entities for construction operations. Contractor shall install approved DC Water meter.



- D. Electric Power Service: Owner will pay electric-power-service use charges for electricity used by all entities for construction operations.
- E. Water and Sewer Service from Existing System: Water from Owner's existing water system is available for use without payment of use charges. Provide connections and extensions of services as required for construction operations.
- F. Electric Power Service from Existing System: Electric power from Owner's existing system is available for use without payment of use charges. Provide connections and extensions of services as required for construction operations.

INFORMATIONAL SUBMITTALS

- A. Site Utilization Plan: Show temporary facilities, temporary utility lines and connections, staging areas, construction site entrances, vehicle circulation, and parking areas for construction personnel.
- B. Safety Plan: Show emergency contacts, rally points, evacuation routes, hot work program, lock out tag out requirements, pedestrian controls, delivery and project access routes, and identification of On Site Safety Supervisor. Plan must comply with OSHA or local jurisdiction requirements, whichever is more stringent
- C. Contractor's Moisture-Protection Plan: Describe delivery, handling, storage, installation, and protection provisions for materials subject to water absorption or water damage.
- D. Project Identification and Temporary Signs: Show fabrication and installation details, including plans, elevations, details, layouts, typestyles, graphic elements, and message content.
- E. LEED Erosion and Sedimentation-Control Plan: Show compliance with requirements of EPA Construction General Permit or authorities having jurisdiction, whichever is more stringent.
- F. Dust and HVAC Control Plan: Submit coordination drawing and narrative that indicates the dust- and HVAC-control measures proposed for use, proposed locations, and proposed time frame for their operation. Identify further options if proposed measures are later determined to be inadequate. Include the following:
 - 1. Locations of dust-control partitions at each phase of work.
 - 2. HVAC system isolation schematic drawing.
 - 3. Location of proposed air-filtration system discharge.
 - 4. Waste handling procedures.
 - 5. Other dust-control measures.

QUALITY ASSURANCE

- A. Tests and Inspections: Arrange for authorities having jurisdiction to test and inspect each temporary utility before use. Obtain required certifications and permits.

PROJECT CONDITIONS

- A. Temporary Use of Permanent Facilities: Engage Installer of each permanent service to assume responsibility for operation, maintenance, and protection of each permanent service during its use as a construction facility before Owner's acceptance, regardless of previously assigned responsibilities.

PRODUCTS

MATERIALS

- A. Chain-Link Fencing: Minimum 2-inch (50-mm), 0.148-inch- (3.8-mm-) thick, galvanized-steel, chain-link fabric fencing; minimum 6 feet (1.8 m) high with galvanized-steel pipe posts; minimum 2-3/8-inch- (60-mm-) OD line posts and 2-7/8-inch- (73-mm-) OD corner and pull posts, with 1-5/8-inch- (42-mm-) OD top rails.
- B. Portable Chain-Link Fencing: Minimum 2-inch (50-mm), 0.148-inch- (3.8-mm-) thick, galvanized-steel, chain-link fabric fencing; minimum 6 feet (1.8 m) high with galvanized-steel pipe posts; minimum 2-3/8-inch- (60-mm-) OD line posts and 2-7/8-inch- (73-mm-) OD corner and pull posts, with 1-5/8-inch- (42-mm-) OD top and bottom rails. Provide concrete or galvanized-steel bases for supporting posts.
- C. Fencing Windscreen Privacy Screen: Polyester fabric scrim with grommets for attachment to chain link fence, sized to height of fence, in color selected by Architect from manufacturer's standard colors.
- D. Wood Enclosure Fence: Plywood, **8 feet (2.4 m)** high, framed with four 2-by-4-inch (50-by-100-mm) rails, with preservative-treated wood posts spaced not more than 8 feet (2.4 m) apart.
- E. Dust-Control Adhesive-Surface Walk-off Mats: Provide mats minimum 36 by 60 inches (914 by 1624 mm).
- F. Insulation: Unfaced mineral-fiber blanket, manufactured from glass, slag wool, or rock wool; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively.

TEMPORARY FACILITIES

- A. Common Use Field Office: Of sufficient size to accommodate needs of Owner, Architect, and construction personnel office activities and to accommodate Project meetings. Keep the office clean and orderly. Furnish and equip offices as follows:
 - 1. Furniture required for Project-site documents including file cabinets, plan tables, plan racks, and bookcases.
 - 2. Conference room of sufficient size to accommodate meetings of 10 individuals. Provide electrical power service and 120-V ac duplex receptacles, with no less than one receptacle on each wall. Furnished room



- with conference table, chairs, and 4-foot (1.2-m-) square tack and marker boards.
 - 3. Drinking water and private toilet.
 - 4. Coffee machine and supplies.
 - 5. Heating and cooling equipment is necessary to maintain a uniform indoor temperature of 68 to 72 deg F (20 to 22 deg C).
 - 6. Lighting fixtures capable of maintaining average illumination of 20 fc (215 lx) at desk height.
 - 7. Provide data/internet connectivity to support owner staff requirements
- B. Storage and Fabrication Sheds: Provide sheds sized, furnished, and equipped to accommodate materials and equipment for construction operations.
- 1. Store combustible materials apart from building.

EQUIPMENT

- A. Fire Extinguishers: Portable, UL rated; with class and extinguishing agent as required by locations and classes of fire exposures.
- B. HVAC Equipment: Unless Owner authorizes use of permanent HVAC system, provide vented, self-contained, liquid-propane-gas or fuel oil heaters with individual space thermostatic control.
- 1. Use of gasoline-burning space heaters, open-flame heaters, or salamander-type heating units is prohibited.
 - 2. Heating Units: Listed and labeled for type of fuel being consumed, by a qualified testing agency acceptable to authorities having jurisdiction and marked for intended location and application.
 - 3. LEED Permanent HVAC System: If Owner authorizes use of permanent HVAC system for temporary use during construction, provide filter with MERV of 8 at each return-air grille in system and remove at end of construction and clean HVAC system.
- C. Air-Filtration Units: Primary and secondary HEPA-filter-equipped portable units with four-stage filtration. Provide single switch for emergency shutoff. Configure to run continuously.

EXECUTION

TEMPORARY UTILITY INSTALLATION

- A. General: Install temporary service or connect to existing service.
- 1. Arrange with utility company, Owner, and existing users for time when service can be interrupted, if necessary, to make connections for temporary services.
- B. Sewers and Drainage: Provide temporary utilities to remove effluent lawfully.
- 1. Connect temporary sewers to municipal system as directed by authorities having jurisdiction.
- C. Water Service: Install water service, meter, and distribution piping in sizes and



pressures adequate for construction.

- D. Water Service: Connect to Owner's existing water service facilities and install an approved DC meter. Clean and maintain water service facilities in a condition acceptable to the Owner. At Substantial Completion, restore these facilities to condition existing before initial use.
- E. Sanitary Facilities: Provide temporary toilets, wash facilities, and drinking water for the use of construction personnel. Comply with requirements of authorities having jurisdiction for type, number, location, operation, and maintenance of fixtures and facilities.
 - 1. Toilets: Use of Owner's existing toilet facilities if approved, as long as facilities are cleaned and maintained daily by the contractor in a condition acceptable to Owner. At Substantial Completion, restore these facilities to condition existing before initial use.
- F. Temporary Heating and Cooling: Unless Owner authorizes use of permanent HVAC system for temporary heating or cooling, provide temporary heating and cooling required by construction activities for curing or drying of completed installations or for protecting installed construction from adverse effects of low temperatures or high humidity. Methods of temporary heating shall be approved by governing agencies having legal jurisdiction. Select equipment that will not have a harmful effect on completed installations or elements being installed.
 - 1. Provide temporary ventilation and dehumidification systems when required to reduce ambient and substrate moisture levels to the level required to allow installation or application of finishes and their proper curing or drying.
- G. Isolation of Work Areas in Occupied Facilities: Prevent dust, fumes, noise, and odors from entering occupied areas.
 - 1. Prior to commencing work, isolate the HVAC system in the area where work is to be performed.
 - a. Disconnect supply and return ductwork in work area from HVAC systems servicing occupied areas.
 - b. Maintain negative air pressure within work area using HEPA-equipped air-filtration units, starting with commencement of temporary partition construction, and continuing until removal of temporary partitions is complete.
 - 2. Maintain dust partitions during the Work. Use vacuum collection attachments on dust-producing equipment. Isolate limited work within occupied areas using portable dust-containment devices.
 - 3. Perform daily construction cleanup and final cleanup using approved, HEPA-filter-equipped vacuum equipment.
- H. Electric Power Service: Connect to Owner's existing electric power service. Maintain equipment in a condition acceptable to Owner.
- I. Electric Power Service: Provide electric power service and distribution system of sufficient size, capacity, and power characteristics required for construction operations.



1. Install electric power service overhead unless otherwise indicated.
- J. Lighting: Provide temporary lighting with local switching that provides adequate illumination for construction operations, observations, inspections, and traffic conditions.
1. Install and operate temporary lighting that fulfills security and protection requirements without operating the entire system.
 2. Install lighting for Project identification sign.
- K. Telephone Service: Provide temporary telephone service in common-use facilities for use by all construction personnel. Install Wi-Fi access equipment or land-based data line(s) for each field office.
1. At each field office entry, post a list of important telephone numbers.
 - a. Police and fire departments.
 - b. Ambulance service.
 - c. Contractor's home office.
 - d. Contractor's emergency after-hours telephone number.
 - e. Architect's office.
 - f. Engineers' offices.
 - g. Owner's office.
 - h. Principal subcontractors' field and home offices.

SUPPORT FACILITIES INSTALLATION

General

- A. Provide construction for temporary offices, shops, and sheds located within construction area or within 30 feet (9 m) of building lines that is noncombustible according.
- B. Maintain support facilities until Architect schedules Substantial Completion inspection. Remove before Substantial Completion. Personnel remaining after Substantial Completion will be permitted to use permanent facilities, under conditions acceptable to the Owner.
- C. Temporary Roads and Paved Areas: Construct and maintain temporary roads and paved areas adequate for construction operations. Locate temporary roads and paved areas within construction limits indicated on Drawings.
 1. Provide dust-control treatment that is nonpolluting and non-tracking. Reapply treatment as required to minimize dust.
- D. Temporary Use of Permanent Roads and Paved Areas: Locate temporary roads and paved areas in the same location as permanent roads and paved areas. Construct and maintain temporary roads and paved areas adequate for construction operations. Extending temporary roads and paved areas, within construction limits indicated, as necessary for construction operations.
 1. Coordinate elevations of temporary roads and paved areas with permanent



- roads and paved areas.
 - 2. Recondition base after temporary use, including removing contaminated material, regrading, proof rolling, compacting, and testing.
 - 3. Delay installation of final course of permanent hot-mix asphalt pavement until immediately before Substantial Completion. Repair hot-mix asphalt base-course pavement before installation of final course.
- E. Traffic Controls: Comply with requirements of authorities having jurisdiction.
- 1. Protect existing site improvements to remain including curbs, pavement, and utilities.
 - 2. Maintain access for fire-fighting equipment and access to fire hydrants.
- F. Parking: Use designated areas of Owner's existing parking areas for construction personnel.
- G. Dewatering Facilities and Drains: Comply with requirements of authorities having jurisdiction. Maintain Project site, excavations, and construction free of water.
- 1. Dispose of rainwater in a lawful manner that will not result in flooding Project or adjoining properties or endanger permanent Work or temporary facilities.
 - 2. Remove snow and ice as required to minimize accumulations.
- H. Project Signs: Provide Project signs as indicated. Unauthorized signs are not permitted.
- 1. Identification Signs: Provide Project identification signs as indicated on Drawings.
 - 2. Temporary Signs: Provide other signs as indicated and as required informing the public and individuals seeking entrance to the Project.
 - a. Provide temporary, directional signs for construction personnel and visitors.
 - 3. Maintain and touchup signs so they are legible at all times.
- I. Waste Disposal Facilities: Provide waste-collection containers in sizes adequate to handle waste from construction operations. Comply with requirements of authorities having jurisdiction. Comply with progress cleaning requirements in Section 01 7300 "Execution."
- J. Lifts and Hoists: Provide facilities necessary for hoisting materials and personnel.
- 1. Truck cranes and similar devices used for hoisting materials are considered "tools and equipment" and not temporary facilities.
- K. Existing Elevator Use: Use of Owner's existing elevators will be permitted, provided elevators are cleaned and maintained in a condition acceptable to Owner. At Substantial Completion, restore elevators to condition existing before initial use, including replacing worn cables, guide shoes, and similar items of limited life.
- 1. Do not load elevators beyond their rated weight capacity.
 - 2. Provide protective coverings, barriers, devices, signs, or other procedures to protect elevator car and entrance doors and frame. If, despite such protection, elevators become damaged, engage Owner's elevator Installer



to restore damaged work so no evidence remains of correction work. Return items that cannot be refinished in field to the shop, make required repairs and refinish entire unit, or provide new units as required.

- L. Temporary Stairs: Until permanent stairs are available, provide temporary stairs where ladders are not adequate.
- M. Existing Stair Usage: Use of Owner's existing stairs will be permitted, provided stairs are cleaned and maintained in a condition acceptable to Owner. At Substantial Completion, restore stairs to condition existing before initial use.
 - 1. Provide protective coverings, barriers, devices, signs, or other procedures to protect stairs and to maintain means of egress. If stairs become damaged, restore damaged areas so no evidence remains of correction
- N. Temporary Use of Permanent Stairs: Use of new stairs for construction traffic will be permitted, provided the stairs are protected and finishes restored to new condition at time of Substantial Completion.

SECURITY AND PROTECTION FACILITIES INSTALLATION

- A. Protection of Existing Facilities: Protect existing vegetation, equipment, structures, utilities, and other improvements at Project site and on adjacent properties, except those indicated to be removed or altered. Repair damage to existing facilities.
- B. Environmental Protection: Provide protection, operate temporary facilities, and conduct construction as required to comply with environmental regulations and that minimize possible air, waterway, and subsoil contamination or pollution or other undesirable effects.
- C. Temporary Erosion and Sedimentation Control: Provide measures to prevent soil erosion and discharge of soil-bearing water runoff and airborne dust to undisturbed areas and to adjacent properties and walkways.
 - 1. Verify that flows of water redirected from construction areas or generated by construction activity do not enter or cross tree- or plant- protection zones.
 - 2. Inspect, repair, and maintain erosion- and sedimentation-control measures during construction until permanent vegetation has been established.
 - 3. Clean, repair, and restore adjoining properties and roads affected by erosion and sedimentation from Project site during the course of Project.
 - 4. Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.
- D. Storm water Control: Comply with requirements of authorities having jurisdiction. Provide barriers in and around excavations and subgrade construction to prevent flooding by runoff of storm water from heavy rains.
- E. Tree and Plant Protection: Install temporary fencing located as indicated or outside the drip line of trees to protect vegetation from damage from construction operations. Protect tree root systems from damage, flooding, and erosion.



- F. Pest Control: Engage pest-control service to recommend practices to minimize attraction and harboring of rodents, roaches, and other pests and to perform extermination and control procedures at regular intervals so Project will be free of pests and their residues at Substantial Completion. Perform control operations lawfully, using materials approved by authorities having jurisdiction.
- G. Site Enclosure Fence: [Before construction operations begin] [Prior to commencing earthwork], furnish and install site enclosure fence in a manner that will prevent people and animals from easily entering site except by entrance gates.
 - 1. Maintain security by limiting the number of keys and restricting distribution to authorized personnel. Furnish one set of keys to Owner.
- H. Security Enclosure and Lockup: Install temporary enclosure around partially completed areas of construction. Provide lockable entrances to prevent unauthorized entrance, vandalism, theft, and similar violations of security. Lock entrances at end of each workday.
- I. Barricades, Warning Signs, and Lights: Comply with requirements of authorities having jurisdiction for erecting structurally adequate barricades, including warning signs and lighting.
- J. Temporary Egress: Maintain temporary egress from existing occupied facilities as indicated and as required by authorities having jurisdiction.
- K. Covered Walkway: Erect protective, covered walkway for passage of individuals through or adjacent to Project site. Coordinate with entrance gates, other facilities, and obstructions. Comply with regulations of authorities having jurisdiction and requirements indicated on Drawings.
 - 1. Provide overhead decking, protective enclosure walls, handrails, barricades, warning signs, exit signs, lights, safe and well-drained walkways, and similar provisions for protection and safe passage.
 - 2. Paint and maintain appearance of walkway for duration of the Work.
- L. Temporary Enclosures: Provide temporary enclosures for protection of construction, in progress and completed, from exposure, foul weather, other construction operations, and similar activities. Provide temporary weathertight enclosure for building exterior.
 - 1. Where heating or cooling is needed and permanent enclosure is incomplete, insulate temporary enclosures.
- M. Temporary Partitions: Provide floor-to-ceiling dustproof partitions to limit dust and dirt migration and to separate areas occupied by Owner from fumes and noise.
 - 1. Construct dustproof partitions with 20 gauge steel studs, gypsum wallboard with joints taped on occupied side, and fire-retardant-treated plywood on construction operations side.
 - a. Construct vestibule and airlock at each entrance through temporary partition with not less than 48 inches (1219 mm) between doors.



Maintain water-dampened foot mats in vestibule.

2. Where fire-resistance-rated temporary partitions are indicated or are required by authorities having jurisdiction, construct partitions according to the rated assemblies.
 3. Insulate partitions to control noise transmission to occupied areas.
 4. Seal joints and perimeter. Equip partitions with gasketed dustproof doors and security locks where openings are required.
 5. Protect air-handling equipment.
 6. Provide walk-off mats at each entrance through temporary partition.
- N. Temporary Fire Protection: Install and maintain temporary fire-protection facilities of types needed to protect against reasonably predictable and controllable fire losses.
1. Prohibit smoking in construction areas.
 2. Supervise welding operations, combustion-type temporary heating units, and similar sources of fire ignition according to requirements of authorities having jurisdiction.
 3. Develop and supervise an overall fire-prevention and -protection program for personnel at Project site. Review needs with local fire department and establish procedures to be followed. Instruct personnel in methods and procedures. Post warnings and information.
 4. Provide temporary standpipes and hoses for fire protection. Hang hoses with a warning sign stating that hoses are for fire-protection purposes only and are not to be removed. Match hose size with outlet size and equip with suitable nozzles.

MOISTURE AND MOLD CONTROL

- A. Contractor's Moisture-Protection Plan: Describe delivery, handling, storage, installation, and protection provisions for materials subject to water absorption or water damage.
1. Indicate procedures for discarding water-damaged materials, protocols for mitigating water intrusion into completed Work, and replacing water-damaged Work.
 2. Indicate sequencing of work that requires water, such as sprayed fire-resistive materials, plastering, and terrazzo grinding, and describe plans for dealing with water from these operations. Show procedures for verifying that wet construction has dried sufficiently to permit installation of finish materials.
 3. Indicate methods to be used to avoid trapping water in finished work.
- B. Exposed Construction Phase: Before installation of weather barriers, when materials are subject to wetting and exposure and to airborne mold spores, protect as follows:
1. Protect porous materials from water damage.
 2. Protect stored and installed material from flowing or standing water.
 3. Keep porous and organic materials from coming into prolonged contact with concrete.
 4. Remove standing water from decks.



5. Keep deck openings covered or dammed.
- C. Partially Enclosed Construction Phase: After installation of weather barriers but before full enclosure and conditioning of building, when installed materials are still subject to infiltration of moisture and ambient mold spores, protect as follows:
1. Do not load or install drywall or other porous materials or components, or items with high organic content, into a partially enclosed building.
 2. Keep interior spaces reasonably clean and protected from water damage.
 3. Periodically collect and remove waste containing cellulose or other organic matter.
 4. Discard or replace water-damaged material.
 5. Do not install material that is wet.
 6. Discard, replace, or clean stored or installed material that begins to grow mold.
 7. Perform work in a sequence that allows any wet materials adequate time to dry before enclosing the material in drywall or other interior finishes.
- D. Controlled Construction Phase of Construction: After completing and sealing of the building enclosure but prior to the full operation of permanent HVAC systems, maintain as follows:
1. Control moisture and humidity inside building by maintaining effective dry-in conditions.
 2. Use permanent HVAC system to control humidity.
 3. Comply with manufacturer's written instructions for temperature, relative humidity, and exposure to water limits.
 - a. Hygroscopic materials that may support mold growth, including wood and gypsum-based products, that become wet during the course of construction and remain wet for 48 hours are considered defective.
 - b. Measure moisture content of materials that have been exposed to moisture during construction operations or after installation. Record readings beginning at time of exposure and continuing daily for 48 hours. Identify materials containing moisture levels higher than allowed. Report findings in writing to Architect.
 - c. Remove materials that cannot be completely restored to their manufactured moisture level within 48 hours.

OPERATION, TERMINATION, AND REMOVAL

- A. Supervision: Enforce strict discipline in use of temporary facilities. To minimize waste and abuse, limit availability of temporary facilities to essential and intended uses.
- B. Maintenance: Maintain facilities in good operating condition until removal.
1. Maintain operation of temporary enclosures, heating, cooling, humidity control, ventilation, and similar facilities on a 24-hour basis where required to achieve indicated results and to avoid possibility of damage.
- C. Temporary Facility Changeover: Do not change over from using temporary security and protection facilities to permanent facilities until Substantial



Completion.

- D. Termination and Removal: Remove each temporary facility when the need for its service has ended, when it has been replaced by authorized use of a permanent facility, or no later than Substantial Completion. Complete or, if necessary, restore permanent construction that may have been delayed because of interference with temporary facility. Repair damaged Work, clean exposed surfaces, and replace construction that cannot be satisfactorily repaired.
 - 1. Materials and facilities that constitute temporary facilities are property of Contractor. The owner reserves the right to take possession of Project identification signs.
 - 2. Remove temporary roads and paved areas not intended for or acceptable for integration into permanent construction. Where area is intended for landscape development, remove soil and aggregate fill that do not comply with requirements for fill or subsoil. Remove materials contaminated with road oil, asphalt and other petrochemical compounds, and other substances that might impair growth of plant materials or lawns. Repair or replace street paving, curbs, and sidewalks at temporary entrances, as required by authorities having jurisdiction.

PRODUCT REQUIREMENTS

GENERAL

PRODUCT WARRANTIES

- A. Warranties specified in other Sections shall be in addition to, and run concurrently with, other warranties required by the Contract Documents. Manufacturer's disclaimers and limitations on product warranties do not relieve Contractor of obligations under requirements of the Contract Documents.
 - 1. Manufacturer's Warranty: Written warranty furnished by individual manufacturer for a particular product and specifically endorsed by manufacturer to Owner.
 - 2. Special Warranty: Written warranty required by the Contract Documents to provide specific rights for Owner.
- B. Special Warranties: Prepare a written document that contains appropriate terms and identification, ready for execution.
 - 1. Manufacturer's Standard Form: Modified to include Project-specific information and properly executed.
 - 2. Specified Form: When specified forms are included with the Specifications, prepare a written document using indicated form properly executed.
 - 3. See other Sections for specific content requirements and particular requirements for submitting special warranties.



EXECUTION

GENERAL

PROGRESS CLEANING

- A. General: Clean Project site and work areas daily, including common areas. Enforce requirements strictly. Dispose of materials lawfully.
 - 1. Do not hold waste materials more than 7 days during normal weather or 3 days if the temperature is expected to rise above 80 deg F (27 deg C).
 - 2. Containerize hazardous and unsanitary waste materials separately from other waste. Mark containers appropriately and dispose of legally, according to regulations.
 - a. Use containers intended for holding waste materials of type to be stored.
- B. Site: Maintain Project site free of waste materials and debris.
- C. Work Areas: Clean areas where work is in progress to the level of cleanliness necessary for proper execution of the Work.
 - 1. Remove liquid spills promptly.
 - 2. Where dust would impair proper execution of the Work, broom-clean or vacuum the entire work area, as appropriate.
- D. Installed Work: Keep installed work clean. Clean installed surfaces according to written instructions of manufacturer or fabricator of product installed, using only cleaning materials specifically recommended. If specific cleaning materials are not recommended, use cleaning materials that are not hazardous to health or property and that will not damage exposed surfaces.
- E. Concealed Spaces: Remove debris from concealed spaces before enclosing the space.
- F. Exposed Surfaces in Finished Areas: Clean exposed surfaces and protect as necessary to ensure freedom from damage and deterioration at time of Substantial Completion.
- G. Waste Disposal: Do not bury or burn waste materials on-site. Do not wash waste materials down sewers or into waterways.
- H. During handling and installation, clean and protect construction in progress and adjoining materials already in place. Apply protective covering where required to ensure protection from damage or deterioration at Substantial Completion.
- I. Clean and provide maintenance on completed construction as frequently as necessary through the remainder of the construction period. Adjust and lubricate operable components to ensure operability without damaging effects.



- J. Limiting Exposures: Supervise construction operations to assure that no part of the construction, completed or in progress, is subject to harmful, dangerous, damaging, or otherwise deleterious exposure during the construction period.

CLOSEOUT PROCEDURES

GENERAL

SUMMARY

- A. Section includes administrative and procedural requirements for contract closeout, including, but not limited to, the following:
 1. Substantial Completion procedures.
 2. Final completion procedures.
 3. Warranties.
 4. Final cleaning.
 5. Repair of the Work.

ACTION SUBMITTALS

- A. Product Data: For cleaning agents.
- B. Contractor's List of Incomplete Items: Initial submittal at Substantial Completion.
- C. Certified List of Incomplete Items: Final submittal at Final Completion.

CLOSEOUT SUBMITTALS

- A. Certificates of Release: From authorities having jurisdiction.
- B. Certificate of Insurance: For continuing coverage.
- C. Field Report: For pest control inspection.

MAINTENANCE MATERIAL SUBMITTALS

- A. Schedule of Maintenance Material Items: For maintenance material submittal items specified in other Sections.

SUBSTANTIAL COMPLETION PROCEDURES

- A. Contractor's List of Incomplete Items: Prepare and submit a list of items to be completed and corrected (Contractor's punch list), indicating the value of each item on the list and reasons why the Work is incomplete.
- B. Submittals Prior to Substantial Completion: Complete the following a minimum of 10 days prior to requesting inspection for determining date of Substantial Completion. List items below that are incomplete at time of request.
 1. Certificates of Release: Obtain and submit releases from authorities having



- jurisdiction permitting Owner unrestricted use of the Work and access to services and utilities. Include occupancy permits, operating certificates, compliance documents, and similar releases.
2. Submit closeout submittals, including project record documents, operation and maintenance manuals, final completion construction photographic documentation, damage or settlement surveys, property surveys, and similar final record information.
 3. Submit closeout submittals, including specific warranties, workmanship bonds, maintenance service agreements, final certifications, and similar documents.
 4. Submit maintenance material, including tools, spare parts, extra materials, and similar items, and deliver to location designated by American University Material Supply Manager. Label with manufacturer's name, model number, and American University Asset Identification Number.
 - a. Schedule of Maintenance Material Items: Prepare and submit schedule of maintenance material submittal items, including name and quantity of each item and name and number of related Specification Section. Obtain American University Project Manager's signature for receipt of submittals and contractor shall transmit items to American University Material Supply Manager for final signature of receipt.
 5. Submit test/adjust/balance records.
 6. Submit sustainable design submittals not previously submitted.
 7. Submit changeover information related to Owner's occupancy, use, operation, and maintenance.
- C. Procedures Prior to Substantial Completion: Complete the following a minimum of 10 days prior to requesting inspection for determining date of Substantial Completion. List items below that are incomplete at time of request.
1. Advise Owner of pending insurance changeover requirements.
 2. Make final changeover of permanent locks and deliver keys to Owner. Advise Owner's personnel of changeover in security provisions.
 3. Complete startup and testing of systems and equipment.
 4. Perform preventive maintenance on equipment used prior to Substantial Completion.
 5. Instruct Owner's personnel in operation, adjustment, and maintenance of products, equipment, and systems. Submit demonstration and training video recordings specified in Section 017900 "Demonstration and Training."
 6. Advise Owner of changeover in heat and other utilities.
 7. Participate with Owner in conducting inspection and walkthrough with local emergency responders.
 8. Terminate and remove temporary facilities from Project site, along with mockups, construction tools, and similar elements.
 9. Complete final cleaning requirements, including touchup painting.
 10. Touch up and otherwise repair and restore marred exposed finishes to eliminate visual defects.
- D. Inspection: Submit a written request for inspection to determine Substantial Completion a minimum of 10 days prior to date the work will be completed and ready for final inspection and tests. On receipt of request, the Architect will either



proceed with inspection or notify Contractor of unfulfilled requirements. Architect will prepare the Certificate of Substantial Completion after inspection or will notify Contractor of items, either on Contractor's list or additional items identified by Architect and Commissioning Agent, that must be completed or corrected before certificate will be issued.

1. Request reinspection when the Work identified in previous inspections as incomplete is completed or corrected.
2. Results of completed inspection will form the basis of requirements for final completion.

FINAL COMPLETION PROCEDURES

- A. Submittals Prior to Final Completion: Before requesting final inspection for determining final completion, complete the following:
 1. Certified List of Incomplete Items: Submit certified copy of Architect's Substantial Completion inspection list of items to be completed or corrected (punch list), endorsed and dated by Architect and Commissioning Agent. A certificate copy of the list shall state that each item has been completed or otherwise resolved for acceptance.
 2. Certificate of Insurance: Submit evidence of final, continuing insurance coverage complying with insurance requirements.
 3. Submit pest-control final inspection report.
 4. Submit final completion photographic documentation.
- B. Inspection: Submit a written request for final inspection to determine acceptance a minimum of 10 days prior to date the work will be completed and ready for final inspection and tests. On receipt of request, Architect will either proceed with inspection or notify Contractor of unfulfilled requirements. Architect will prepare a final Certificate for Payment after inspection or will notify Contractor of construction that must be completed or corrected before certificate will be issued.
 1. Request reinspection when the Work identified in previous inspections as incomplete is completed or corrected.

LIST OF INCOMPLETE ITEMS (PUNCH LIST)

- A. Organization of List: Include name and identification of each space and area affected by construction operations for incomplete items and items needing correction including, if necessary, areas disturbed by Contractor that are outside the limits of construction.
 1. Organize list of spaces in sequential order, starting with exterior areas first and proceeding from lowest floor to highest floor.
 2. Organize items applying to each space by major element, including categories for ceiling, individual walls, floors, equipment, and building systems including commissioning items.
 3. Include the following information at the top of each page:
 - a. Project name.
 - b. Date.
 - c. Name of Architect.
 - d. Name of Contractor.



- e. Page number.
4. Submit list of incomplete items in MS Excel, PDF electronic file, or other format acceptable to Architect.

SUBMITTAL OF PROJECT WARRANTIES

- A. Time of Submittal: Submit written warranties on request of Architect for designated portions of the Work where warranties are indicated to commence on dates other than date of Substantial Completion, or when delay in submittal of warranties might limit Owner's rights under warranty.
- B. Partial Occupancy: Submit properly executed warranties within 15 days of completion of designated portions of the Work that are completed and occupied or used by Owner during construction period by separate agreement with Contractor.
- C. Organize warranty documents into an orderly sequence based on the table of contents of Project Manual.
- D. Provide additional copies of each executed warranty to include in operation and maintenance manuals.
- E. Warranty Electronic File: Provide executed warranties and bonds in PDF format. Assemble complete executed warranty and bond submittal package into a single electronic PDF file with bookmarks enabling navigation to each item. Provide bookmarked table of contents at beginning of document.
 1. Submit on digital media acceptable to the Owner, and/or by uploading to web-based project software site.

EXECUTION

FINAL CLEANING

- A. General: Perform final cleaning. Conduct cleaning and waste-removal operations to comply with local laws and ordinances and Federal and local environmental and antipollution regulations.
- B. Cleaning: Employ experienced workers or professional cleaners for final cleaning. Clean each surface or unit to the condition expected in an average commercial building cleaning and maintenance program. Comply with manufacturer's written instructions.
 1. Complete the following cleaning operations before requesting inspection for certification of Substantial Completion for entire Project or for a designated portion of Project:
 - a. Clean Project site, yard, and grounds, in areas disturbed by construction activities, including landscape development areas, of rubbish, waste material, litter, and other foreign substances.
 - b. Sweep paved areas broom clean. Remove petrochemical spills,



- stains, and other foreign deposits.
- c. Rake grounds that are neither planted nor paved to a smooth, even-textured surface.
- d. Remove tools, construction equipment, machinery, and surplus material from Project site.
- e. Remove snow and ice to provide safe access to building.
- f. Clean exposed exterior and interior hard-surfaced finishes to a dirt-free condition, free of stains, films, and similar foreign substances. Avoid disturbing natural weathering of exterior surfaces. Restore reflective surfaces to their original condition.
- g. Remove debris and surface dust from limited access spaces, including roofs, plenums, shafts, trenches, equipment vaults, manholes, attics, and similar spaces.
- h. Sweep concrete floors broom clean in unoccupied spaces.
- i. Vacuum carpet and similar soft surfaces, removing debris and excess nap; clean according to manufacturer's recommendations if visible soil or stains remain.
- j. Clean transparent materials, including mirrors and glass in doors and windows. Remove glazing compounds and other noticeable, vision-obscuring materials. Polish mirrors and glass, taking care not to scratch surfaces.
- k. Remove labels that are not permanent.
- l. Wipe surfaces of mechanical and electrical equipment, elevator equipment, and similar equipment. Remove excess lubrication, paint and mortar droppings, and other foreign substances.
- m. Clean plumbing fixtures to a sanitary condition, free of stains, including stains resulting from water exposure.
- n. Replace disposable air filters and clean permanent air filters. Clean exposed surfaces of diffusers, registers, and grills.
- o. Clean ducts, blowers, and coils if units were operated without filters during construction or that display contamination with particulate matter on inspection.
- p. Clean, repair, or replace damaged or soiled ceilings, ceiling tiles, and fixtures. Painting of ceiling tiles and/or grid is not acceptable.
- q. Clean light fixtures, lamps, globes, and reflectors to function with full efficiency.
- r. Leave Project clean and ready for occupancy.

REPAIR OF THE WORK

- A. Complete repair and restoration operations before requesting inspection for determination of Substantial Completion.
- B. Repair, or remove and replace, defective construction. Repairing includes replacing defective parts, refinishing damaged surfaces, touching up with matching materials, and properly adjusting operating equipment. Where damaged or worn items cannot be repaired or restored, provide replacements.



Remove and replace operating components that cannot be repaired. Restore damaged construction and permanent facilities used during construction to specified condition.

1. Remove and replace chipped, scratched, and broken glass, reflective surfaces, and other damaged transparent materials.
2. Touch up and otherwise repair and restore marred or exposed finishes and surfaces. Replace finishes and surfaces that already show evidence of repair or restoration.
3. Do not paint over "UL" and other required labels and identification, including mechanical and electrical nameplates. Remove paint applied to required labels and identification. Replace parts subject to operating conditions during construction that may impede operation or reduce longevity.
4. Replace burned-out bulbs, bulbs noticeably dimmed by hours of use
5. Replace defective and noisy starters in fluorescent to comply with requirements for new fixtures.

OPERATION AND MAINTENANCE DATA

GENERAL

CLOSEOUT SUBMITTALS

- A. Provide content for each manual as specified in individual Specification Sections. Submit reviewed manual content formatted and organized as required by this Section.
 1. The owner will comment on whether the content and organizational format of operation and maintenance submittals is acceptable.
 2. Where applicable, clarify and update reviewed manual content to correspond to revisions and field conditions.
- B. Format: Submit operation and maintenance manuals in the following format:
 1. Searchable PDF with table of contents
- C. Initial Manual Submittal: Submit draft electronic copy of each manual at least 30 days before commencing demonstration and training. The Owner will comment on whether the general scope and content of the manual are acceptable.
 1. Correct or revise each manual to comply with Owner comments.
- D. Final Manual Submittal: Submit each manual in final form prior to requesting inspection for Substantial Completion and at least 14 days before commencing demonstration and training.

FORMAT OF OPERATION AND MAINTENANCE MANUALS

- A. Manuals, Electronic Files: Submit manuals in the form of a multiple file composite electronic PDF file for each manual type required.
 1. File Names and Bookmarks: Bookmark individual documents based on file names. Name document files to correspond to system, subsystem, and



equipment names used in manual directory and table of contents. Group documents for each system and subsystem into individual composite bookmarked files, then create composite manual, so that resulting bookmarks reflect the system, subsystem, and equipment names in a readily navigated file tree. Configure electronic manual to display bookmark panel on opening file.

REQUIREMENTS FOR EMERGENCY, OPERATION, AND MAINTENANCE MANUALS

- A. Organization of Manuals: Unless otherwise indicated, organize each manual into a separate section for each system and subsystem, and a separate section for each piece of equipment not part of a system. Each manual shall contain the following materials, in the order listed:
 - 1. Title page.
 - 2. Table of contents.
 - 3. Manual contents.

- B. Title Page: Include the following information:
 - 1. Subject matter included in manual.
 - 2. Name and address of Project.
 - 3. Name and address of Owner.
 - 4. Date of submittal.
 - 5. Name and contact information for Contractor.
 - 6. Name and contact information for Construction Manager.
 - 7. Name and contact information for Architect.
 - 8. Name and contact information for Commissioning Authority.
 - 9. Names and contact information for major consultants to the Architect that designed the systems contained in the manuals.
 - 10. Cross-reference to related systems in other operation and maintenance manuals.

- C. Table of Contents: List each product included in manual, identified by product name, indexed to the content of the volume, and cross-referenced to Specification Section number in Project Manual.
 - 1. If operation or maintenance documentation requires more than one volume to accommodate data, include a comprehensive table of contents for all volumes in each volume of the set.

EMERGENCY MANUALS

- A. Emergency Manual: Assemble a complete set of emergency information indicating procedures for use by emergency personnel and by Owner's operating personnel for types of emergencies indicated.

- B. Content: Organize manual into a separate section for each of the following:
 - 1. Type of emergency.
 - 2. Emergency instructions.
 - 3. Emergency procedures.

- C. Type of Emergency: Where applicable for each type of emergency indicated



below, include instructions and procedures for each system, subsystem, piece of equipment, and component:

1. Fire.
 2. Flood.
 3. Gas leak.
 4. Water leak.
 5. Power failure.
 6. Water outage.
 7. System, subsystem, or equipment failure.
 8. Chemical release or spill.
- D. Emergency Instructions: Describe and explain warnings, trouble indications, error messages, and similar codes and signals. Include responsibilities of Owner's operating personnel for notification of Installer, supplier, and manufacturer to maintain warranties.
- E. Emergency Procedures: Include the following, as applicable:
1. Instructions on stopping.
 2. Shutdown instructions for each type of emergency.
 3. Operating instructions for conditions outside normal operating limits.
 4. Required sequences for electric or electronic systems.
 5. Special operating instructions and procedures including alarms.
 6. Restart and Release requirements.

SYSTEMS AND EQUIPMENT OPERATION MANUALS

- A. Systems and Equipment Operation Manual: Assemble a complete set of data indicating operation of each system, subsystem, and piece of equipment not part of a system. Include information required for daily operation and management, operating standards, and routine and special operating procedures.
1. Prepare a separate manual for each system and subsystem, in the form of an instructional manual for use by Owner's operating personnel.
- B. Content: In addition to requirements in this Section, include operation data required in individual Specification Sections and the following information:
1. System, subsystem, and equipment descriptions. Use designations for systems and equipment indicated on Contract Documents.
 2. Performance and design criteria if Contractor has delegated design responsibility.
 3. Operating standards.
 4. Operating procedures.
 5. Operating logs.
 6. Wiring diagrams.
 7. Control diagrams.
 8. Piped system diagrams.
 9. Precautions against improper use.
 10. License requirements including inspection and renewal dates.



- C. Descriptions: Include the following:
 - 1. Product name and model number. Use designations for products indicated on Contract Documents.
 - 2. Manufacturer's name.
 - 3. Equipment identification with serial number of each component.
 - 4. Equipment function.
 - 5. Operating characteristics.
 - 6. Limiting conditions.
 - 7. Performance curves.
 - 8. Engineering data and tests.
 - 9. Complete nomenclature and number of replacement parts.

- D. Operating Procedures: Include the following, as applicable:
 - 1. Startup procedures.
 - 2. Equipment or system break-in procedures.
 - 3. Routine and normal operating instructions.
 - 4. Regulation and control procedures.
 - 5. Adjustment parameters.
 - 6. Instructions on stopping.
 - 7. Normal shutdown instructions.
 - 8. Seasonal and weekend operating instructions.
 - 9. Required sequences for electric or electronic systems including alarms.
 - 10. Special operating instructions and procedures.

- E. Systems and Equipment Controls: Describe the sequence of operation, and diagram controls as installed.

- F. Piped Systems: Diagram piping as installed and identify color-coding where required for identification.

- G. Systems and Equipment Maintenance Manuals: Assemble a complete set of data indicating maintenance of each system, subsystem, and piece of equipment not part of a system. Include manufacturers' maintenance documentation, preventive maintenance procedures and frequency, repair procedures, wiring and systems diagrams, lists of spare parts, and warranty information.

- H. Manufacturers' Maintenance Documentation: Include the following information for each component part or piece of equipment:
 - 1. Standard maintenance instructions and bulletins; include only sheets pertinent to product or component installed. Mark each sheet to identify each product or component incorporated into the Work. If data include more than one item in a tabular format, identify each item using appropriate references from the Contract Documents. Identify data applicable to the Work and delete references to information not applicable.
 - a. Prepare supplementary text if manufacturers' standard printed data are not available and where the information is necessary for proper operation and maintenance of equipment or systems.



2. Drawings, diagrams, and instructions required for maintenance, including disassembly and component removal, replacement, and assembly.
 3. Identification and nomenclature of parts and components.
 4. List of items recommended to be stocked as spare parts.
- I. Maintenance Procedures: Include the following information and items that detail essential maintenance procedures:
1. Test and inspection instructions.
 2. Troubleshooting guide.
 3. Precautions against improper maintenance.
 4. Disassembly; component removal, repair, and replacement; and reassembly instructions.
 5. Aligning, adjusting, and checking instructions.
 6. Demonstration and training video recording, if available.
- J. Maintenance and Service Schedules: Include service and lubrication requirements, list of required lubricants for equipment, and separate schedules for preventive and routine maintenance and service with standard time allotment.
1. Scheduled Maintenance and Service: Tabulate actions for daily, weekly, monthly, quarterly, semiannual, and annual frequencies.
 2. Maintenance and Service Record: Include manufacturers' forms for recording maintenance.
- K. Spare Parts List and Source Information: Include lists of replacement and repair parts, with parts identified and cross-referenced to manufacturers' maintenance documentation and local sources of maintenance materials and related services.
- L. Maintenance Service Contracts: Include copies of maintenance agreements with name and telephone number of service agent.
- M. Warranties and Bonds: Include copies of warranties and bonds and lists of circumstances and conditions that would affect validity of warranties or bonds.
1. Include procedures to follow and required notifications for warranty claims.
- N. Drawings: Prepare drawings supplementing manufacturers' printed data to illustrate the relationship of component parts of equipment and systems and to illustrate control sequence and flow diagrams. Coordinate these drawings with information contained in record Drawings to ensure correct illustration of completed installation.
1. Do not use original project record documents as part of maintenance manuals.

PRODUCT MAINTENANCE MANUALS

- A. Product Maintenance Manual: Assemble a complete set of maintenance data indicating care and maintenance of each product, material, and finish



incorporated into the Work.

- B. Content: Organize manual into a separate section for each product, material, and finish. Include source information, product information, maintenance procedures, repair materials and sources, and warranties and bonds, as described below.
- C. Source Information: List each product included in manual identified by product name and arranged to match manual's table of contents. For each product, list name, address, and telephone number of Installer or supplier and maintenance service agent, and cross-reference Specification Section number and title in Project Manual and drawing or schedule designation or identifier where applicable.
- D. Product Information: Include the following, as applicable:
 - 1. Product name and model number.
 - 2. Manufacturer's name.
 - 3. Color, pattern, and texture.
 - 4. Material and chemical composition.
 - 5. Reordering information for specially manufactured products.
- E. Maintenance Procedures: Include manufacturer's written recommendations and the following:
 - 1. Inspection procedures.
 - 2. Types of cleaning agents to be used and methods of cleaning.
 - 3. List of cleaning agents and methods of cleaning detrimental to product.
 - 4. Schedule for routine cleaning and maintenance.
 - 5. Repair instructions.
- F. Repair Materials and Sources: Include lists of materials and local sources of materials and related services.
- G. Warranties and Bonds: Include copies of warranties and bonds and lists of circumstances and conditions that would affect validity of warranties or bonds.
 - 1. Include procedures to follow and required notifications for warranty claims.

PROJECT RECORD DOCUMENTS

GENERAL

CLOSEOUT SUBMITTALS

- A. Record Drawings: Comply with the following:
 - 1. Number of Copies: Submit copies of record Drawings as follows:
 - a. Initial Submittal:
 - 1) Submit PDF electronic files of scanned record prints and 1 of file prints.
 - 2) Submit record digital data files including and 1 set of plots.
 - 3) Architect will indicate whether general scope of changes,



additional information recorded, and quality of drafting are acceptable.

- b. Final Submittal:
 - 1) Submit PDF electronic files of scanned record prints and 1 sets of prints.
 - 2) Submit recorded digital data including .dwg files and complete Revit file and 1 set(s) of record digital data file plots.
 - 3) [Print] [Plot] each drawing file, whether or not changes and additional information were recorded.
- B. Record Specifications: Submit annotated PDF electronic files of Project's Specifications, including addenda and contract modifications.
- C. Record Product Data: Submit annotated PDF electronic files and directories of each submittal.
 - 1. Where record Product Data are required as part of operation and maintenance manuals, submit duplicate marked-up Product Data as a component of manual.
- D. Miscellaneous Record Submittals: See other Specification Sections for miscellaneous record-keeping requirements and submittals in connection with various construction activities. Submit annotated PDF electronic files and directories of each submittal.

RECORD DRAWINGS

- A. Record Digital Data Files: Immediately before inspection for Certificate of Substantial Completion, review marked-up record prints with Architect. When authorized, prepare a full set of corrected digital data files of the Contract Drawings, as follows:
 - 1. Format: Same digital data software program, version, and operating system as the original Contract Drawings.
 - 2. Format: Annotated PDF electronic file with comment function enabled.
 - 3. Incorporate changes and additional information previously marked on record prints. Delete, redraw, and add details and notations where applicable.
 - 4. Refer instances of uncertainty to Architect for resolution.
 - 5. Architect will furnish Contractor one set of digital data files of the Contract Drawings for use in recording information.
 - a. See Section 01 3100 "Project Management and Coordination" for requirements related to use of Architect's digital data files.
 - b. Architect will provide data file layer information. Record markups in separate layers.
- B. Format: Identify and date each record Drawing; include the designation "PROJECT RECORD DRAWING" in a prominent location.
 - 1. Record Prints: Organize record prints and newly prepared record Drawings



- into manageable sets. Bind each set with durable paper cover sheets. Include identification on cover sheets.
2. Format: Annotated PDF electronic file with comment function enabled.
 3. Record Digital Data Files: Organize digital data information into separate electronic files that correspond to each sheet of the Contract Drawings. Name each file with the sheet identification. Include identification in each digital data file.
 4. Identification: As follows:
 - a. Project name.
 - b. Date.
 - c. Designation "PROJECT RECORD DRAWINGS."
 - d. Name of Architect.
 - e. Name of Contractor.

RECORD SPECIFICATIONS

- A. Preparation: Mark Specifications to indicate the actual product installation where installation varies from that indicated in Specifications, addenda, and contract modifications.
 1. Give particular attention to information on concealed products and installations that cannot be readily identified and recorded later.
 2. For each principal product, indicate whether record Product Data has been submitted in operation and maintenance manuals instead of submitted as record Product Data.
 3. Note related to Change Orders, record Product Data, and record Drawings where applicable.
- B. Format: Submit record Specifications as annotated PDF electronic file.

RECORD PRODUCT DATA

- A. Recording: Maintain one copy of each submittal during the construction period for project record document purposes. Post changes and revisions to project record documents as they occur; do not wait until the end of the Project.
- B. Preparation: Mark Product Data to indicate the actual product installation where installation varies substantially from that indicated in Product Data submittal.
 1. Include significant changes in the product delivered to the Project site and changes in manufacturer's written instructions for installation.
 2. Note related Change Orders, record Specifications, and record Drawings where applicable.
- C. Format: Submit record Product Data as annotated PDF electronic file.
 1. Include record Product Data directory organized by Specification Section number and title, electronically linked to each item of record Product Data.



GENERAL COMMISSIONING REQUIREMENTS

GENERAL

- A. Reference the Commissioning Specifications for General Commissioning Requirements.



AMERICAN UNIVERSITY
DESIGN STANDARDS
TECHNICAL REQUIREMENTS BY DIVISION



DIVISION 2 EXISTING CONDITIONS

The American University Campus has unique architectural and exterior spatial design qualities, especially around the Freidheim Quadrangle. All Site work shall follow current LEED guidelines for Site Selection as applicable to the particular project requirements at the University.

SPECIFIC DESIGN PARAMETERS

The design of new buildings, renovation of existing facilities and site improvement projects shall accomplish the following:

1. Adhere to the AU Campus Plan.
2. Respect the historic fabric and detail of the Campus and integrate each built project into the surrounding Campus context.
3. Emphasize safe and attractive pedestrian circulation within the Campus and arrival into the Campus to provide:
 - a. clear arrival sequence
 - b. accessibility as required by Americans with Disabilities Act (ADA): durable slip-resistant materials, site lighting and emergency telephones, screening of service functions, orientation to and framing of special views
 - c. Accommodate safe and convenient vehicular circulation, arrival, drop-off and parking.
4. Provide safe, attractive and functional outdoor spaces.
5. Provide suitable horticultural soils, drainage and irrigation to support successful horticultural development and sustainability.
6. Emphasize the use of plants for energy conservation and ecological appropriateness.
7. Retain mature trees wherever possible, particularly where they occur in groups, through creative use of retaining walls, bio-retention, grading and other site design techniques.
8. Maintain aesthetic consistency.

SITE DESIGN STANDARDS

All campus site designs shall meet the campus wide standards established by the University for landscaping, irrigation, parking, drainage and utilities.

All site design shall comply with all applicable DC codes and applicable sections of current LEED guidelines. Requirements in Division 32 Exterior Improvements and Division 33 Utilities are applicable.

STRUCTURE DEMOLITION 02 41 16

Provide Facility Management Energy and Engineering with footprint (area in square feet) of buildings, structures, and associated site improvements removed during construction for impervious service credit with DC Water. Demolition date required.

END OF DIVISION 2



DIVISION 3 CONCRETE

GENERAL

Concrete design shall be in accordance with the latest edition of the DC Building Code and comply with requirements of the American Concrete Institute (ACI); specifically, the requirements of ACI-301, ACI-318 for reinforced concrete structures, ACI 3xx for hot weather construction and ACI-306 for cold-weather construction. Design strength shall be appropriate to the use intended but shall be a minimum 3000 psi (at 28 days).

The Contractor shall provide a design mix from a commercial testing laboratory approved by the Consultant, using samples of aggregates and cement approved for use. Cost of the design mix preparation shall be borne by the Contractor.

Admixtures in concrete used for building design shall be approved by the Owner and shall be in accordance with requirements of the project, relative to hot weather, cold weather, pour schedules, sustainability and other special project requirements.

In support of project LEED requirements and AU sustainability goals, consider the following:

1. Require fly ash, slag cement, silica fume and/or another pre-consumer recycled material for concrete. Require post-consumer recycled material in the aggregate. <http://greenlivingideas.com/2008/12/21/can-concrete-be-eco-friendly/>
2. Set an overall target as per the LEED formula so: $(\text{Product Cost} * \text{Preconsumer \%} * 0.5) + (\text{Product Cost} * \text{Post-Consumer \%}) \geq$ to 20% of total concrete spend
3. Slag cement dramatically reduces embodied energy and greenhouse gas emissions in concrete. Most slag cement in the U.S. is recovered at iron blast furnaces located within the U.S. or Canada.
4. Silica fume is a byproduct of producing silicon metal or ferrosilicon alloys. One of the most beneficial uses for silica fume is in concrete. Concrete containing silica fume can have very high strength and can be very durable.
5. For all materials included in CSI specification sections 2–10, provide the total hard cost of each material (excluding labor and equipment). Be sure to include manufacturing and extraction locations and manufacturer's data, and/or product information confirming the product's sustainable attributes (such as percentage of re-cycled content, certifications).

Curing components used in slabs shall be compatible with applied finishes, including vinyl flooring and carpeting. The Contractor shall measure moisture content in slab construction prior to installation of these finishes; all installation will be performed in accordance with the manufacturer's requirements.



Testing services for concrete are to be paid for by the Owner and conducted by an independent testing laboratory selected by the Owner. Laboratory-cured test specimens and field-cured specimens shall be used to confirm the quality and strength of the concrete material. A list that includes the type, quantity and frequency of tests shall be kept for all tests.

STRUCTURAL CONCRETE – 03 41 00

Perlite and vermiculite are not permitted for use in structural concrete; fly ash is preferred.

END OF DIVISION 3



DIVISION 4 MASONRY

GENERAL

Concrete Masonry Units, brick and other masonry units exposed to view shall be approved by the Owner based on compatibility in color and texture with existing exterior building materials on Campus. Sample panels shall be constructed in order to obtain approval by the Consultant and the Owner.

Masonry units shall match or complement adjacent buildings as closely as possible.

Careful consideration will be given by the Consultant to design of the wall with regard to cavity wall construction, flashing details, control joints, mortar joint details and wall materials.

Masonry shall be measured for moisture presence prior to installation of final paint coatings.

Prevention of efflorescence is of critical importance in the mortar mix design and installation.

RENOVATION PROJECTS

In renovation projects involving exterior stone, brick, or other masonry: existing units shall be carefully removed and reused if possible. If new material is needed, it shall closely match the existing wall.

Masonry joint repairs for older structures shall be made in accordance with requirements of historic structures, with regard to proper mortar mix, color range and proper pointing procedure.

CLEANING OF MASONRY – 04 01 10

Cleaning agents shall include diluted detergents, nonmetal bristle brushes, potable water and non-acid washing solutions. The use of abrasive brushes or cleaning agents is not permitted. Sandblasting of masonry is not permitted.

END OF DIVISION 4



DIVISION 5 METALS

GENERAL

All exterior exposed ferrous material, including ornamental frames, steel gratings, stairs, handrails, plaques and structural elements shall be hot-dipped galvanized after fabrication and protected from corrosion by a method acceptable to the Owner. Preference should be given to final finishes that are maintenance free (no cyclic painting).

Using screws to attach metal roof decks to structures is recommended, but attachment of metal decks by welding is allowed, with the condition that the welding be inspected and approved by the Consultant prior to installation of the final roof covering. The Consultant shall inspect composite deck assemblies.

Anchorage of structural elements or ornamental assemblies shall be clearly detailed. Bolt sizes shall be indicated.

Where downspouts are utilized in the building design, cast iron boots shall be provided to connect downspouts to underground drainage lines.

Tolerances, connections, attachment to metals, coping and clearances shall be detailed on the construction documents.

Metal materials/products shall contain the maximum amount of recycled content allowed that retains material integrity and contain as much locally harvested and processed or extracted and processed material (within 500 miles) as feasible.

Any adhesives or sealants used must comply with maximum allowable VOC requirements. Submit product cut sheets indicating recycled content, place of origin, and VOC levels. Track all purchases as a percentage of total spend complying with each sustainability criterion.

END OF DIVISION 5



DIVISION 6 COMPOSITES, PLASTICS AND WOOD

GENERAL

Wood, composite, and plastic materials/products shall contain the maximum amount of recycled content allowed that retains material integrity, contain as much locally harvested and processed or extracted and processed (within 500 miles) material, rapidly renewable material, and FSC-certified content as feasible. Any adhesives or sealants, paints or coatings must comply with the maximum allowable VOC. Composite and Agri fiber products must contain no added urea formaldehyde resins. Contractor shall submit product cut sheets indicating recycled content, place of origin, rapidly renewable material, FSC-certified wood content, VOC levels, and urea formaldehyde resin limits, as applicable. Track all purchases as a percentage of total spend complying with each sustainability criterion.

ROUGH CARPENTRY – 06 10 00, 06 10 53, 06 10 63

Preservative-treated lumber shall be used in damp areas and shall be used when in contact with concrete, masonry, plaster and roof blocking. Material shall be kiln-dried to a maximum 15% for plywood and 19% for lumber moisture content after treatment.

The Consultant shall carefully consider anchorage, joint connections and bracing in the design of the truss system. Heavy timber or laminated timber shall not be exposed to weather. Design load data for truss design shall be shown on the project drawings.

Blocking and grounds shall be installed plumb and in alignment, in order to ensure proper fit of subsequent finish material (such as wood trim, gypsum board or plaster), treated with fire retardant chemicals to provide a flame spread classification of 25 or less.

Countertops with sinks shall be solid surfacing material or quartz composite. Countertops in dry areas can be laminate. Coordinate with the Project Manager on selection of materials required for specialty areas such as laboratories, animal facilities, and wash down areas.

FINISH CARPENTRY – 06 20 13, 06 20 23

Endangered tree and plant species, including redwood, shall not be permitted.

Wood trim with transparent finish shall be appropriate to the design of the building or project. Painted or concealed wood trim shall be fir, birch or poplar.

Particleboard is not permitted for use in any application including cabinets, carpentry, countertops and sheathing.



Blocking and finish material shall be installed to allow for natural wood movement and building movement.

END OF DIVISION 6



DIVISION 7 THERMAL AND MOISTURE PROTECTION

GENERAL

The Consultant must consider the effects of environmental design factors; that is, the degenerative forces exerted on roofing systems and wall systems by exterior and interior conditions. These forces include sunlight exposure, rainfall, ice, snow, wind, the chemical environment and the installation environment. The task is to select components that will withstand such environmental factors, integrate these components into a complete system, and integrate Indoor Environmental Quality, Environment and Atmosphere requirements from the current LEED rating system in use.

Building occupancy factors should be considered in the design of roofing systems and wall systems. Humidity and occupancy help determine the necessity for vapor retarders and venting. Any occupancy with a chemical function, such as laboratories, will require special consideration. The system should be designed so that temperature and relative humidity can be controlled. Particular attention must be paid to operating costs.

Thermal and moisture protection materials/products shall contain the maximum amount of recycled content allowed that retains material integrity, contain as much locally harvested and processed or extracted and processed (within 500 miles) material, and FSC-certified content as feasible. Any adhesives or sealants must comply with the maximum allowable VOC requirements as defined by the applicable reference standard (e.g. SCAQMD). Submit product cut sheets indicating recycled content, place of origin, FSC-certified wood content, and VOC levels, as applicable. Track all purchases as a percentage

Density of insulation must be sufficient to allow foot traffic or other traffic on the roof. Resistance to water, liquid and vapor shall be specified. Select and install insulation for reuse in re-roofing.

Specify roof insulation by type and manufacturer. Specify minimum density or compressive strength. Specify roof insulation in order to obtain a "total system" warranty from the roofing manufacturer.

Specify application criteria. The insulation shall be two or more layers, with joints staggered.

Mechanical attachment is prohibited except on a steel metal deck; in this case, mechanically attach the first layer and fully adhere the next.

The Consultant must specify a "Class A" fire rated roof assembly on all University buildings. The assembly shall include both the deck and the insulation systems. Material used shall not contain asbestos.



Architectural metal and structural standing-seam roofing shall have a minimum slope of 4 inches per foot. Copper, lead-coated copper and terne-coated stainless steel are preferred.

Limit the use of exposed fasteners through the panels to end and side panels. Specify systems that do not penetrate the panels. Use continuous no-seam panels. Avoid skylight panels due to problems with leaks, condensation and safety concerns.

EXTERIOR WALL ASSEMBLIES

There are two important factors in designing exterior walls that should be incorporated into the roofing system:

1. Ensure that with the addition of the specified thickness of insulation, tapered insulation and associated crickets and saddles, there is a minimum 8" clear flashing height
2. Precautions should be taken to ensure that water cannot migrate from the exterior walls or curbs into the roofing system

Parapet walls and interior roof curbs should be part of the roof deck, not independent of the roof deck.

Incorporate parapet walls in the building design if possible. This will provide greater resistance to wind up-lift and provide a safer place for maintenance personnel to work. Keep the roof shape as simple as possible.

Two-piece, through-wall flashings should be installed at all masonry walls. Through-wall metal reduces the possibility of water entering the roofing system or building interior through vertical wall cavities. Weepholes should be provided on top of the through-wall metal to allow escape of any water entering the wall above the metal.

The exterior wall assembly or interior curbs shall be independent of the roofing system. Design the assembly so it will not interfere with future re-roofing of the building.

ROOFING

Several factors repeatedly show up during the inspection of roofs that have failed prematurely. They include inappropriate use of materials, poor drainage systems, poor details for installation of roof accessories, damage by construction traffic and poor access to all parts of the roof area. The design of a roof should incorporate these fundamental features: appropriate and proven materials, good drainage and drains, good accessory details, proper protection and good access to the roof and areas around roof-mounted equipment.



RE-ROOFING

Re-roofing projects are basically the same as new construction, except that thorough investigation is needed to determine conditions of the existing building, and projects must consider the condition and usability of existing flashings.

Protect building components from damage during the re-roofing process.

Water shedding roofs with a slope greater than 4" per foot shall be specified whenever practical. Low slope roofs shall be sloped a minimum of ¼" per ft.

Avoid locating long skylights, HVAC units and other obstructions perpendicular to the slope. Furnish crickets where necessary to provide drainage around obstructions. Valleys should not be located over a beam-column line.

DRAINAGE

Do not locate drains adjacent to roof columns, adjacent to walls that support decks or adjacent to walls that are extended to the roof deck. Locate drains symmetrically in order to simplify the tapered insulation design.

OVERFLOWS

Conductor heads should have an overflow port, permitting water to escape if the down-spout becomes obstructed.

Scuppers should be sloped outward and downward. An overflow scupper should be designed so that no more than 6 inches of water will accumulate at the inlet if the drain fails to work.

INTERNAL DRAINAGE SYSTEMS

A sump created by tapered insulation should be provided at the drain to lower it below the level of the roof.

Vertical leaders must have expansion joints at the drains if there is any possibility of deck movement. Horizontal leaders must be insulated to prevent condensation from forming and dripping to the ceiling.

Drains and slopes should be shown on a separate architectural roof plan. Key elevations and slope arrows should be given to the roofing contractor.

Mechanical equipment rooms above the lowest floor shall be curbed to prevent flooding. Incorporate ceiling mounted lifting eyes for ease of removal on equipment exceeding sixty (60) pounds installed five (5) feet or more above finished floor. Should ceiling restrictions exist, design should include sufficient space for using a portable lifting device.



New mechanical equipment rooms (MER's) shall be designed to have access from the outside, via an opening large enough to facilitate the removal of the largest piece (or component) of equipment therein. It is desirable that access by truck be incorporated where possible.

American University requires that the Consultant minimize the visual impact of any equipment that must be located on building roofs. Where placement of such equipment is unavoidable, it shall be designed so that penetration of the roofing system is minimized. Adequate maintenance access shall be provided. Rooftop walkways, access to the roof by a service elevator and other necessary measures shall be included.

Consultant shall provide calculations to confirm structural adequacy from an engineer licensed by the District of Columbia and submit to Owner for review and Project Record. Equipment should not be installed above ceilings. Where this is unavoidable, or where units are installed in concealed locations, there should be auxiliary drain pans independently piped to drains and access panels to allow for full service and equipment removal. Auxiliary drain pans shall be independently supported.

Ample space shall be provided for service access to all equipment, including pulling tubes for converters, chillers and air-handling unit coils.

Lifting eyes shall be provided in equipment rooms in which the moving of heavy equipment is anticipated and for above ceiling equipment.

For renovation projects that involve small equipment rooms, direct access to the rooms from a corridor or a public space is required.

DRAIN TYPE

Drain receivers should be used on metal decks and other types of decks that may need the distributed loading for a secure connection to the deck. Threaded drains do not leak as often as hot-poured or caulked drains.

PENETRATIONS

Minimize penetrations through the roof membrane. Route the penetrations through side walls when possible. Use curbs; do not use pitch pockets. Reference the NRCA manuals for approved details.

ACCESSIBILITY TO ROOF

Walkout access from a stairwell extension is preferred. Access from a penthouse is also acceptable. Doors and hatches providing roof access shall have locks.

Provide hose bibs and electrical outlets on the roof for maintenance purposes. On a large roof, multiple access points at opposite ends will prevent unnecessary backtracking.

When stairways are not required, a roof scuttle shall be provided. It shall be a minimum



2'x 4' in size and have a fixed ladder. Where roof access is frequent and involves moving machinery and equipment, increase the size of the roof hatch to 3" x 5". Include handrails and hatch restraints. Confirm with American University Risk Management the final layout of ladders, supports, and ease of equipment lifting to minimize employee injury.

DECKING

Deck selection should be made in close regard to the assembly category selected and may often dictate system component type. Because the deck is the foundation of the roof system, consideration for design should be based on stability.

INSULATION – 07 21 00

No other component of a building has a greater influence on the life-cycle costs or greater effect on other building components. Thus, careful thought must be given to thermal insulation, insulation type, location its durability, flammability and formaldehyde content. When renovating or fitting out an existing space, a thorough inspection and careful consideration must be given to the presence or condition of existing insulation to determine what repairs, replacement or new installations are necessary. It is important to ensure damaged insulation is removed and new insulation is properly installed, secured and sealed in accordance with industry standards and the manufacturer's requirements.

The Consultant in accordance with Energy and Building codes shall determine "R" factors and "U" factors. Do not simply specify that roof insulation must meet a certain "R" or "U" factor for the roof structure; the Consultant should decide on the insulation best suited to the project, make the calculation and specify a thickness that enables the project to meet ASHRAE 90.1 requirements per LEED guidelines of minimum energy performance prerequisite (EA_p2) and project building target for optimized energy performance (EA_c1).

VAPOR RETARDERS – 07 26 00

Vapor retarders should be used only when necessary, as they tend to hide leaks in a roof system until large areas of insulation become wet. This results in an increase in the size of the damaged roof area, which translates into an increased cost for repairs.

FLASHING AND SHEET METAL – 07 62 00

All flashings should be detailed to permit thermal movement and to shed water "mechanically" by lapping. The detail shall be designed without the use of sealants. Thermal expansion will generally, over time, exceed the performance capacity of most sealants.

Keep the roof "clean" of penetrations and equipment. Do not install a metal roof if there is equipment that needs to be maintained or if there is an excessive number of penetrations planned.

Keep the roof design simple and sustainable. Use continuous panels, if possible, rather



than joining smaller panels using exposed fasteners.

All sheet metal materials should be designed for easy removal without interfering with building operations. No conduit or piping should be attached to coping covers. Where pipes cross over flashings or wall tops, there should be sufficient clearance to permit removal of metal without disturbing the pipes.

All metals used in the roofing assembly shall be of the same type and material. Preferred materials: copper, stainless steel, terne-coated stainless steel and aluminum

Mechanical or interlocking joints are preferred to ensure that wide metal sections stay in contact and do not admit water through open laps at metal joints.

Wood blocking attached on the perimeter of the roof must be pressure treated and provided in strict accordance with FM requirements for an I-90 rating.

With the use of metal gravel guards and fascia, temperature movements in heavy gauge metal must be considered. If heavy gauge metal is used, gravel guards should not be heavier than 24 to 26--gauge stainless steel, 16-ounce copper or 30-to 40 mil aluminum in maximum 10' lengths. Hook strips should be one gauge heavier than the fascia.

Gutters should be designed so they can be replaced without damaging the roof edges.

ROOF SPECIALTIES AND ACCESSORIES – 07 7100, 07 7720

If approved by the Owner, roof-mounted equipment must be supported on a properly constructed curb or an elevated metal frame.

Curbs must extend either a minimum of 8 inches above the finished roof surface or above the height of any emergency overflow pipe or scupper. See NRCA Details "IL-2" and "N" for fan curbs and equipment requiring a continuous edge curb.

Metal frames should be used to support heavy equipment or structures above the roof surface. Clearance below equipment shall be as suggested by NRCA Detail "M-1." Provide approved walkway pads up to and around equipment requiring frequent service or inspection. Location of pads to be confirmed by the Owner.

JOINT SEALERS – 07 92 00

Caulking should be reserved for sealing joints in vertical surfaces between relatively stable components of the building. It should not be used where significant water will stand or regularly run across the joint.

END OF DIVISION 7



DIVISION 8 OPENINGS

GENERAL

Doors, Windows and other openings are critical to efficient building envelopes and effective building security. Ensure that security features are coordinated with Division 28 requirements located within this document.

In renovation and fit out projects such components no longer in serviceable condition shall be repaired or replaced.

Windows, Doors or Openings no longer able to maintain envelope integrity shall also be identified, costed and considered for replacement as part of design efforts.

All doors shall have a minimum 3'-0" width and 7'-0" height. Heavy duty hinges or continuous hinges are required. Knock down frames are to be avoided.

Knock down door frames shall be avoided.

All doors shall have locking hardware approved by the security representative of American University.

Opening's materials/products shall be built with FSC Certified wood cores and veneers and/or contain the maximum amount of recycled content allowed that retains material integrity, contain as much locally harvested and processed or extracted and processed (within 500 miles) material, and rapidly renewable content as feasible.

All exterior doors and jambs should be hollow metal (steel) or aluminum and glass (storefront systems) made from recyclable material. Steel doors shall be a minimum of 16 gauge; jambs shall be a minimum of 14 gauge.

All exterior handicap door access operator switches must be completely protected from the weather. Door controls and push plates must be hard wired. Door operators must work with card readers where applicable.

Doors in high-traffic areas, loading docks, mechanical rooms, and corridors must be designed to include metal door edge guards and protection plates on both sides. The frame and door hardware shall be designed to accept this additional weight.

See entryway walk off mat requirements in Division 12 Furnishings.



EXTERIOR ENTRANCE DOORS

Preferred entrance doors are Fiberglass Reinforced Polyester (FRP) Exit Door Systems by Special-Lite or approved equal.

Provide extra space for and factory installed bracing for door hardware, automatic openers, and access control and/or security wiring.

Entrance doors shall have door sweeps and/or manufacturers gasket assemblies suitable for pest exclusion.

Continuous hinges are preferred.

FLOOR AND JAMB ANCHORS

The number of anchors provided on each jamb shall follow manufacturer's recommendation for commercial applications.

Floor anchors shall be securely welded or screwed inside each jamb, with two holes provided at each jamb for anchorage.

Frames for installation in masonry walls shall be provided with adjustable wire type jamb anchors. Anchors shall be not less than 0.156" diameter steel wire.

Frames for installation in stud partitions shall be provided either with steel anchors of not less than 18 gauge thickness, securely welded inside each jamb, or insert type with notched clip to engage stud inserted to back of the frame as identified above.

FABRICATION AND STORAGE

Stave lumber doors shall be AWI specification symbol SLC-5. Wood used in construction of the doors shall be thoroughly seasoned, low-density, non-resinous, kiln-dried hardwood with moisture content between 5% and 8%.

Contractors shall store and transport doors as per the manufacturer's requirements. The Contractor shall replace doors and frames damaged by improper storage and moving upon request.

All doors trimmed on site shall be resealed or primed and painted at the trim area. This includes edges and installs in place openings or glass kits.



Doors with missing, altered or unreadable ratings will be rejected and replaced at no cost to the University.

METAL DOORS AND FRAMES

Fire-rated doors required to be B-Label classification shall be made of recycled metal. On labeled fire doors, all closers shall be of a "non-hold-open" type approved by Underwriters Laboratories (UL).

Fire rated doors that open to corridors and contain glass shall use 1/4" UL fire-rated tempered glass.

Where specified or scheduled, doors shall be provided with either aluminum or steel moldings to secure glass in accordance with glass opening sizes as shown on approved shop drawings.

WINDOW ASSEMBLIES

In large window assemblies, install a double balance in order to provide a window that is easier to open and to decrease the frequency of repairs.

Operable windows above ground level may require the addition of safety hardware to limit opening. Confirm feasibility of operable windows readily accessible from the ground with Risk Management.

All screws and other miscellaneous fastening devices incorporated in the product shall be concealed within the window assembly.

Plastic materials are not acceptable.

Minimum warranties:

- A. Windows shall be warranted against defects in material and workmanship for a period of one (1) year from date of installation
- B. Insulating glass shall be warranted to be free from obstruction of vision by film formation or dust collection between the interior surfaces of the glass panes for a period of ten (10) years from date of installation pigmented organic finishes of the window and related component parts shall be warranted against blistering, cracking, peeling or chipping for a period of fifteen (15) years from the date of installation
- C. Where natural ventilation strategies are used, LEED and ASHRAE standards



must be met to comply with applicable code and regulatory requirements and shall support AU's continuous commissioning LEED prototype for Indoor Air Quality (IAQ).

FIRE-RATED FLUSH WOOD DOORS – 08 14 16

Type and construction shall be the standard of the manufacturer, with the following exceptions:

1. Provide balanced construction by furnishing manufacturer's laminated stile edge for improved screw holding to both stiles of all C-Label and B-Label doors
2. Stile edge split resistance shall exceed 751 pounds, in accordance with ASTM D143-52

SOUND-RETARDANT DOORS – 08 34 73

Doors shall have the AWI specification symbol SR. Doors shall be five-ply and shall be the standard of the manufacturer, with matching edge strips bonded to particleboard or stave lumber core with resin glue.

Doors shall be furnished complete with automatic threshold-sealing-device gaskets. Doors shall be not less than 1 3/4" (unless otherwise stated), according to the manufacturer's standard, in order to provide the sound transmission class specified.

OVERHEAD COILING DOORS – 08 33 23

All overhead doors shall be serviceable. Standard manufacturer is Overhead Door Company due to existing in- place service contract.

HARDWARE – 08 71 00, 08 71 11

Prepare steel frame units to receive mortised and concealed hardware (including cut-outs, reinforcing, drilling and tapping) in accordance with the final finish Hardware Schedule and templates provided by the hardware supplier. Comply with requirements of ANSI A115.1.

Coordinate all door hardware selections for access and security with requirements with University Safety and Security Services. Door assemblies may require additional width or bracing to accommodate required security hardware.



AUTOMATIC DOOR OPERATORS – 08 71 13

For doors heavier than 350 pounds, the Consultant will request product and/or performance information for review by Facilities Management.

Provide additional backing to accommodate the door operator.

Include one-year emergency service, required maintenance with end of warranty adjustment during the first year after Substantial Completion.

END OF DIVISION 8



DIVISION 9 FINISHES

GENERAL

The Consultant shall consider the use of the space and long-term maintenance requirements in the selection of finishes

Finishes shall contain the maximum amount of recycled content allowed that retains material integrity, contain as much locally harvested and processed or extracted and processed (within 500 miles) material, rapidly renewable material, and FSC-certified content as feasible.

Submit product cut sheets indicating recycled content, place of origin, rapidly renewable material content, FSC-certified wood content, and VOC levels, as applicable. Track all purchases as a percentage of total spend complying with each sustainability criterion

Some existing walls, ceiling tile, insulation, floor tile and acoustical plaster contain asbestos or are finished with lead-based paint. The Owner surveys the project during the planning process to determine which areas need to be abated prior to the beginning of construction.

Existing to remain finishes, equipment and surfaces within renovations will be reviewed for cleaning or restoration during the project. Examples include handrails, light fixtures, and ceiling grid.

CEILING PANELS

Panels shall generally be a directional-fissured design unless a special design is necessary to a "feature" area. Panels shall be smooth vinyl when used in high-moisture locations such as food-preparation and toilet areas.

Concealed spline ceilings are not recommended. Return air plenums are not desirable, but where they occur, hold-down clips shall be provided at ceiling panels.

Corner trim shall be provided where grid changes direction at wall. Light fixtures, smoke detectors, sprinkler heads, speakers and fire horns shall be centered within tiles. Check with Facilities Management for individual building standards.

Selecting acoustical tile products already in-use and stocked on campus is encouraged.



Concrete floors shall be examined, and tested if required, for the presence of moisture or foreign materials prior to the application of new finishes.

New concrete slab areas shall be designed with curing compounds or other admixtures to be compatible with final floor finishes.

FLOOR COVERINGS

LEED and Green Source guidelines shall be followed for floor coverings.

LATH AND PLASTER

Many of the walls on Campus are plaster. In renovation projects, it is preferred to patch plaster with a plaster material compatible with the existing material. When existing plaster ceilings are penetrated directly for mechanical or electrical work, the plaster shall be patched tightly in order to maintain the existing fire and acoustical protection.

Exterior plaster shall be reinforced with galvanized metal lath and the tie wires shall be stainless steel. Exterior plaster shall be designed as cement plaster or stucco, according to the use of the space.

WALL COVERINGS

Wall coverings are generally not recommended, unless as designed in feature areas and approved by the Owner. An exception is frequently made for custom accent graphics.

The Consultant shall consider the following in selecting wall coverings:

- A. Type 1 commercial vinyl or reinforced fabric required
- B. flame spread must be 25 or less
- C. good cleanability
- D. low maintenance

GYPSUM WALLBOARD – 09 29 00

Drywall construction generally shall be designed to be consistent with the institutional nature of the Campus, with regard to use and abuse by the occupants and the function of the space.



CERAMIC TILE – 09 301 3

Ceramic tile with a "non-slip" finish shall be recommended for toilet areas, and ceramic wall tile shall be employed around floor-mop receptors.

Grouts shall be selected for long-term service and cleanability, as well as for flexural and tensile strength and sustainability. Generally, acrylic latex emulsions shall be used in general use areas, and epoxy additives used for chemical-resistant or food-preparation areas.

Floor drain design shall be coordinated with tile installation, and the tile shall be cut neatly around the floor drain.

WOOD FLOORING – 09 64 00

Wood flooring is not recommended for use in facilities except for gyms, performing-arts areas or areas where wood floors already exist because of high maintenance needs.

RESILIENT FLOORING – 09 96 16

Existing vinyl asbestos tile to remain in place shall not be penetrated by core drilling, attachment of equipment or by any other manner.

Solid (un-patterned) colors are not recommended due to scratching and maintenance considerations except possibly for use in border designs or accent strips. Vinyl tile shall not be used in high-moisture areas. Seamless flooring, with a minimal number of joints, is recommended for laboratory areas and to meet LEED requirements.

A rubber base is recommended and should be a minimum .080 gauge cove type for use with direct-glue-down carpet or vinyl flooring. In laboratory areas, use an "integral" base with flooring if seamless flooring is chosen.

TERRAZZO- 09 66 13, 09 66 23

Terrazzo used in public areas shall employ non-slip aggregate or finish. The Consultant shall consider expansion joint design and placement in coordination with structural movement of the building. Exterior terrazzo is generally not recommended. Terrazzo is not recommended for toilet areas. Integral terrazzo cove-type base is recommended.



CARPET – 09 68 13, 09 68 16

The Owner may elect to purchase carpet directly from the mill and have the Contractor install it, or the Owner may require the Contractor to supply and install the carpet. Traffic patterns, use of the space and maintenance requirements must be considered in the

selection of carpet. The use of carpet tile, modular tile or border accent tile are preferred, when appropriate.

PAINTING – 09 91 13, 09 91 23

Surfaces shall be adequately prepared for painting by filling, scraping, sanding, caulking, priming, cleaning or brushing; the presence of any moisture in areas to be painted is unacceptable.

Although epoxy paint is desirable in high-moisture or abuse areas, its curing time and odor must be accounted for in potentially sensitive areas. Pre-finished (factory finished) items shall not be painted.

Fire protection and other life safety devices shall not be painted.

Receptacle, switches or similar cover plates shall be removed for painting and replaced.

On previously painted surfaces, a minimum of one coat of finish paint shall be provided. If patching is required, a primer and at least two finish coats shall be used. Paints are to be applied by brush or roller; spray painting is not permitted.

Touch up of holidays shall be corner to corner to minimize observable variance in paint application.

END OF DIVISION 9



DIVISION 10 SPECIALTIES

GENERAL

All items shall have a factory finish, with no field painting required.

Fasteners shall be concealed. Fasteners located against or inserted into walls should be galvanized; exposed fasteners should be stainless steel.

The Designer shall provide, in the design of every new building, the following provisions and spaces, with net areas as indicated in the Service Space Allocation Division. Refer to departmental requirements such as the FM Space Needs document in the references section at www.american.edu/standards.

SERVICE CLOSETS

Service closets (typically described in 01 57 00) containing floor-mop receptors shall incorporate the following:

- mop receptors shall contain a waterproofing membrane on the floor, installed prior to placement of the basin
- built-in mop receptors shall be lined in ceramic tile and/or ceramic tile wainscot shall be provided on the walls of the service closet to a height of 6 feet above the floor
- shelving shall be provided for storage of housekeeping supplies
- power as needed for equipment
- keying and use separate from other operational units

CUSTODIAL EQUIPMENT ROOMS

Minimum Size: 60 square feet per 22,000 sq. ft. of gross area.

Location: Room should be strategically located on all floors

Shape: Room shall be rectangular.

Designer to confirm room size is sufficient for maintenance equipment storage and use. Some equipment requires electrical or water connections.

DRY TRASH ROOMS

Shall be located directly off the loading dock and from a corridor. They shall be of fire-proof construction and shall be protected with sprinklers.



FACILITIES MAINTENANCE CONTROL ROOM

Minimum size 80 square feet can serve a building size up to 80,000 gross square feet. 100 square feet size room will serve a building over 80,000 square feet up to 175,000 gross square feet. A 160 square feet size room will serve a building having over 175,000 gross square feet.

FACILITIES MAINTENANCE REQUIREMENTS

The Designer will need to accommodate restrictions on shared space and access to address departmental contractual, safety and service requirements. Generally, FM does not share service space with other departments. For example, do not co-locate OIT and FM equipment. Similarly, University Housekeeping and FM do not share space.

VENDING AREAS

Slip-resistant tile or commercial-grade sheet vinyl flooring shall be employed in these areas. Auxiliary Services (AS) coordinates the placement of vending machines and the Consultant shall coordinate electrical, plumbing and the placement of card reader wiring items with this office.

Project vending area shall consider placement of outlets, drainage, visual placement of the units, accessibility to the units, floor texture at area of machines (vinyl flooring or nonskid hard surfacing is recommended), adequate lighting and adequate ventilation.

WET WASTE OR HAZARDOUS WASTE ROOMS

If required by the building usage, shall be located directly off the loading dock and from a corridor. The room shall be fireproof and shall provide other protection as determined by the nature of the waste material. Designer should consult with the American University Environmental Health and Safety Office before the design process begins. Provide 60 sq. ft. minimum for chemistry or similar laboratory facilities.

VISUAL DISPLAY BOARDS – 10 11 00

Marker boards shall be white porcelain-type boards, for use with felt-tipped markers made from sustainable material.

Chalkboards shall be porcelain enamel steel with matte writing surface and minimum 1/4" thick hardboard backing.

Tack boards shall be cork surfacing on minimum 1/4" thick hardboard backing.

Marker boards and chalkboards generally shall have aluminum trim and continuous



chalk troughs.

TOILET COMPARTMENTS – 10 21 13

Partitions and doors shall be made of recycled phenolic material and shall be anchored to the floor or ceiling mounted and provided with overhead bracing and an approved handrail. (Side panels and door panels shall be a minimum 1" thick. Stainless steel plinths (movable for cleaning) on pilasters shall be provided.)

TOILET AND BATH ACCESSORIES – 10 28 00

Toilet Accessories (tissue dispensers, towel dispensers and soap dispensers and sanitary napkin disposals) will be provided by the Owner and installed by the General Contractor.

Other toilet or bath accessories provided and installed by the General Contractor shall be made of stainless steel, with provision for concealed mounting.

Tissue dispensers must be mounted so they are clear of the compartment's grab bars and "door swing," and should not be mounted with screw heads visible on the wall of adjacent compartments.

Bath accessories in residence halls may be Contractor supplied and installed. Consult with University Housekeeping on length of stocked shower curtains and confirm required overlap prior to mounting rod.

Provide blocking in walls as necessary for mounting of equipment.

LOCKERS – 10 51 13

Metal lockers shall consist of a minimum of 16 gauge bodies and doorframes of cold rolled, recycled steel with baked enamel finish. Lockers shall be placed on a concrete base, or approved alternative and shall have sloped tops or built into the wall and provision for padlocks. Number plates and interior coat hooks shall be furnished.

In some instances, wood lockers with melamine interior and laminated plastic exterior finish shall be considered.

Coordinate keying scheme and labeling of lockers jointly with department and University Lock Shop.



SIGNAGE – 10 14 23

Larger projects may require the use of a building directory, which shall be a type in which information can be changed without special tools. Directional signage shall be considered part of the signage system for each project. In some instances, the use of cast bronze plaques with raised letters is required for a dedicatory function. The Owner shall furnish text for the plaque.

A uniform system of signs for the Campus is necessary for ease of maintenance and replacement. American University has adopted exterior and interior sign standards. All campus signage projects must follow the current sign standards. The designer should consult with Planning and Project Management.

FIRE EXTINGUISHERS/CABINETS – 10 44 13, 10 44 16

The Owner will provide standard ABC fire extinguishers, to be installed by the General Contractor. The General Contractor will supply and install specialty suppression equipment, canisters or extinguishers. Cabinets will be provided and installed by the GC.

Although not required by code, pantries and kitchen areas should have small extinguishers. A fire extinguisher shall be provided in each pantry or common kitchen area where a microwave or other heating appliance is installed.

Fire extinguishers are required in mechanical rooms and elevator rooms.

All contractor supplied fire extinguishers and suppression equipment will be certified prior to Occupancy. Testing of equipment and associated alarms, especially those integrated with the fire alarm system or the HVAC system is required.

END OF DIVISION 10



DIVISION 11 EQUIPMENT

GENERAL

Special equipment shall be designed with the following considerations:

1. Integration with existing systems, equipment or programs
2. Service and maintenance access
3. Maintenance and service life
4. Education of users regarding proper operation of equipment
5. Warranty provisions
6. Replacement parts
7. Recycled content

The Designer should consult with the Office of Information Technology and Audio Visual Services for audiovisual equipment and projection equipment selection criteria and hookup requirements.

ENERGY STAR DESIGN PARAMETERS

Energy Star rated equipment is required for commercial dishwashers, fryers, griddles, hot food holding cabinets, ice machines, ovens, refrigerators and freezers, and steam cookers as well as any other product category as ratings become available.

LABORATORY EQUIPMENT

The Owner may purchase movable equipment, such as balances, refrigeration equipment, centrifuges and other portable laboratory equipment. The Consultant shall closely coordinate the electrical and plumbing tie-ins for this equipment.

Casework generally shall comply with requirements of Division 6 with regard to wood construction and as a basis for manufactured casework. Casework designed for storage of sensitive equipment or for chemical storage shall have locks.

Vacuum and air connections shall be employed in laboratory areas, and gas connections shall be employed where required. Vacuum breakers shall be provided on faucets.

Laboratory casework shall be placed with at least 5 feet between benches to allow for handicap accessibility.

Refrigeration equipment used in laboratory areas may be purchased by the Owner and installed by the Contractor. Refrigeration equipment used for critical experimentation must be placed on emergency electrical back-up service. Consult with the American

University Master Electrician to confirm generator load capacity.



PARKING CONTROL EQUIPMENT – 11 12 00

The Owner currently contracts with parking control vendors to supply this equipment. The Contractor shall supply conduit and wiring to the site of the equipment, and the Owner is responsible for the installation and final connection. The Owner shall supply equipment, drawings and electrical requirements to the Consultant for reference.

Provision should be made for Card Reader equipment to be set in a 3/4" conduit to run from the stand to the gate box. Confirm Pay Box requirements with Transportation and Park Services.

LOADING DOCK BUMPERS – 11 13 13

Dock bumpers shall be provided at loading areas. Coordinate with Facilities Management, Auxiliary Services and department to confirm delivery vehicle types for placement and size of bumpers.

LOADING DOCK EQUIPMENT – 11 13 19

Loading dock edges shall be provided with steel angle edging with steel anchors concealed in concrete. The use of motorized dock levelers is not recommended; the Consultant shall accomplish proper driveway back-up clearance for vehicles on "flat grade" to the dock area, at the height of the vehicles most commonly serving the building.

RESIDENTIAL APPLIANCES – 11 30 13

Equipment selection criteria shall include operating energy rating and usage along with performance. Consult with Housing and Residence Life for the most recently approved list of appliances and requirements.

FOOD SERVICES EQUIPMENT- 11 40 00

Where food service areas are part of the project, the designer shall consult with Planning and Project Management and Office of Campus life (OCL) for design and layout of the space. Food service equipment may be purchased by American University and provided to the Contractor for connection. Refer to the products sections for equipment currently used in food service locations.

Refrigerators, microwave ovens and coffee makers used in lounges or break rooms may be purchased by the Owner. The designer shall provide dedicated electrical circuitry for these items.

LABORATORY FUME HOODS – 11 52 13

Fume hoods and bio-safety hoods may be purchased by the Owner and installed by the
EQUIPMENT



Contractor. The Consultant shall give special attention to ventilation requirements, particularly taking into consideration the types of chemicals used in the laboratories, air velocity sensing devices and the need for emergency back-up power.

Motorized elements such as fans shall be designed to provide protection suited to the type of chemicals used. Safety of the user is of highest priority in hood sash (and opening) design and in the design of ventilating storage cabinets. New fume hood design strategies have been demonstrated to reduce energy use by 75%, while maintaining or enhancing safety. Therefore, High Performance, energy efficient fume hoods (e.g. VAV system equipped with a sensor-based auto sash closure) are required.

FACILITY WASTE BALERS – 11 82 36

Designers should consult with Facilities Management prior to including balers, toters, and dumpsters or compactors in their design. All waste is collected in AU's standard Zero Waste Interior Containers. These materials either are then transported to toters or designated compactors outside. All materials hauled off campus by a contractor is only large open tops or 34 yd. compactors. This type of equipment shall be furnished by the Owner, Contractor Installed.

Waste compactors when included shall have push button controls totally enclosed with dock-fed hopper, guide rolls/stop and hinged breaker bar teeth

Cardboard bales are picked up by internal AU recycling staff and transported to the 15 yd. open top(s) designated for cardboard recycling. Loose and bailed cardboard are collected in this open top that has a covered lid to protect from weather elements. Cardboard is sent to an off-campus recycling facility.

END OF DIVISION 11

DIVISION 12 FURNISHINGS

GENERAL

The Owner usually supplies furnishings. The Owner typically contracts with private vendors who make field measurements, manufacture and install the items. These items include:

- window blinds
- draperies, selected by the Owner and used in certain areas; the Consultant shall coordinate the design of support alcoves and proper substrates to provide for the mounting hardware and rods
- movable rugs
- interior plants
- artwork
- movable furniture and accessories; in larger projects, the Owner may employ the Consultant to assist in the selection of these items through an interior design contract

The furnishings listed above shall be included as part of the overall interior design considerations for the project and shall be included on color presentation boards as required.

All furnishings shall be totally chlorine free, processed chlorine free, and low to non-toxic.

Furnishings that are Owner Supplied, Contractor Installed are identified as such in the project scope of work or specifications.

CUTRAINS AND DRAPES – 12 22 00

All fabrics shall be flame resistant.

MANUFACTURED EQUIPMENT – 12 63 13, 12 32 13, 12 32 16

The decision to purchase the seating outside the construction contract shall be made by the Owner.

The requirements of manufactured casework are similar to casework requirements described in Division 6. On larger projects, the Owner may require mock-up assemblies for review by the user, prior to manufacture. Mock-ups shall include all represented items associated with the assembly, including sinks, backsplashes, finish and hardware.

ENTRANCE MATS – 12 4813, 12 4816

Entrance mats shall be designed according to the following criteria:

- non-slip surface

- wearability and service life (no rotting or mildew)
- ability to clean foot traffic on textured nylon or polypropylene surfaces without "tracking"
- drainage of recessed area
- maintenance and cleaning of recessed areas and mat
- replacement of parts
- color fastness of "colored" mats; drying capability of mats
- stability of the mat system (no "rattling" of slats when walked upon)
- fire resistance

The design of recessed mat systems employing aluminum-edge "slat" type grating or full-perforated rubber or vinyl is not recommended. Entryway systems (grilles, grates, mats) must be at least 10' long in the primary direction of travel to capture dirt and particulates entering the building at all public entry points.

Mat systems should be appropriate for the climate, should have high void volume within fibers, solid backings, fire-retardant ratings that exceed DOC-FF-1-70, and electrostatic propensity levels of less than 2.5 KV. Systems with recycled-content and rubber backings are preferable.

SOLID WASTE BINS

Each waste location will include 3 bins. One for recycling, one for compost/organics and one for landfill trash. The models and manufacturer outlined below are the only acceptable manufacturer and model to match the campus standards. The 30 gallon bins (EC 1119) should be used in lower traffic areas and office suites. The larger 40 gallon bins (EC 1818) should only be used in very high traffic areas. Panel design artwork should be requested from the Zero Waste Manager or ErgoCan.



END OF DIVISION 12



DIVISION 14 CONVEYING SYSTEMS

GENERAL

The Contractor shall provide the University with the final inspection report indicating that the elevator installed complies with all appropriate state and federal codes and regulations. This includes all associated items provided by the manufacturer.

CAR ENCLOSURES

Emergency telephones shall dial into the University Safety and Security Service. Telephone number 202-885-2527.

For elevators that will have utility use, cars may be furnished with removable wall pads and hooks, as well as with handrails. The Designer is to clarify with the Owner.

Cars shall contain a lighted floor indicator above the door or in the return column; soffit mounting is not acceptable. Color shall be blue. Exception Mary Graydon Center passenger elevators indicators are currently red. Consult with Owner to confirm blue or red indicator.

An electrical receptacle for housekeeping purposes shall be provided in the corridor adjacent to the elevator landing on each floor.

Interior cab finish companies shall fall under the control of the elevator installation contractor. Cab finishes shall be determined and approved by the University approved architect.

MACHINE ROOMS, PIT AREAS AND PENTHOUSES

Where equipment is subject to severe or sudden vibrations, sound-deadening material shall be used to isolate any sounds or vibrations from the supporting floor or wall.

Machine rooms shall comply with the latest applicable code with regards to its dimensions, fire protection and atmospheric control.

ELEVATOR CONTROLLERS

Elevator controllers shall be non-proprietary in their design. This is defined as having equipment that in which at least three elevator companies can work on without the use of special tools, passwords and any more technical expertise than is already possessed. Typical non-proprietary manufacturers are ones such as Motion Control or GAL. Proprietary manufacturers are ones such as OTIS, Thyssen-Krupp, and Kone. Although the aforementioned companies tend to offer their own manufactured systems



which are proprietary, if specified, these can install non-proprietary systems.

The installation company shall provide all necessary tools for the purpose of monitoring and or adjusting elevator controllers. This includes any special software or handheld devices normally used.

ELEVATOR DOOR EQUIPMENT

Elevator door equipment shall be from GAL using the closed loop door operator MOVFR system

TRACTION ELEVATORS

When the building design prevents the use of a penthouse machine room or the decision is to not install hydraulic elevators, the installation of Machine Room Less (MRL) traction type elevators can be installed. MRL elevators shall be such that it will not require proprietary tools or equipment to be serviced.

HYDRAULIC ELEVATORS

Hydraulic elevators can be either a single jack system or a dual post jack system. Choice of which jack to install is dependent on ground conditions.

To protect elevator single jack units, the casing and any underground piping shall have an approved coating designed to resist electrolytic and chemical corrosion. The jack shall be installed in a double bottom cylinder. Where drilling for full travel is unavailable, consider using an inverted telescopic jack. The Consultant shall inspect the casing prior to back filling.

VERTICAL WHEELCHAIR LIFTS

The Consultant should submit complete product information to the Project Manager for approval prior to ordering the lift and constructing the surrounding areas. The information should cover major components; lift dimensions, control diagrams, surrounding construction configurations and electrical connections.

The Consultant shall submit to the Owner a certificate indicating that the lift complies with the applicable D.C. Code. This includes all associated items provided by the manufacturer.

Self-closing gates and associated items at top and bottom levels, along with all "electromagnetic" and mechanical hardware, shall comply with the D.C. Vertical Wheelchair Lift Code.

The lift's rated speed shall not exceed 40 feet per minute.



The following guidelines for platforms and ramps shall be observed:

- platforms shall be at least 36" wide and have an inside area of not more than 12 square feet
- platform surfaces shall be constructed of material that is relatively smooth and skid-proof
- ramps shall be provided as required for access to platforms
- ramps shall be designed and constructed as required by the D.C. Vertical Wheelchair Lift Code
- platforms shall be designed and constructed to prevent wheelchairs from leaving the platforms prematurely

STAIR LIFTS

Design shall be in accordance with the conditions in which it is installed. If a stair lift is intended to be exposed to the outside elements, then the design and or equipment shall be such that all operating components will resist corrosion or complication due to the elements.

END OF DIVISION 14



DIVISION 21 FIRE SUPPRESSION

FIRE DETECTION & ALARM

Fire detection and alarm systems are critical in assuring life safety and to protect University owned property. It is imperative that they perform their vital function properly and reliably.

These standards are applicable to new installations of fire and smoke detection and alarm systems in all Campus facilities, as well as all modifications, upgrades and renovations to existing systems.

The contractor shall perform maintenance and adjustments for the duration of the substantial completion warranty period. A full annual inspection shall be conducted prior to turning over the system fully to the University, inclusive of all testing, records, and certificates.

Designer shall review and comply with the provisions within the current version of the Facilities Management (FM) Fire Suppression Master Plan and Fire Alarm Master Plan. All projects or renovations will include monitoring and reporting to the university head end at University Safety and Security Services (located at East Campus) and the Manager of Life Safety Systems (located in Osborne) and include graphics updates.

Equipment identification shall follow the existing Facilities Management asset tag scheme. Submit list of new or replacement equipment to FM Planned Maintenance Manager for confirmation.

Equipment labeling shall follow the AU electrical labeling identifying power source.

All new work or changes require updating of the fire alarms graphics and alarms, which shall be the responsibility of the Contractor.

Designer should review the Generator division specification for integration capabilities with fire alarm system monitoring.

SPRINKLER AND STANDPIPE SYSTEM MONITORING

Each water-flow switch will be provided with an integral 20 to 40 second time delay device to prevent nuisance alarms from surges in water pressure. Permanent provision shall be made for testing each switch by water flow equivalent to that from a standard 1/2 inch sprinkler head.

Separate water-flow switch(es) shall be provided for each floor, just downstream of every zone valve, on each branch from the riser.



Sprinkler supervisory circuits for monitoring valve tamper are limited to no more than three valves each, on either one floor or one riser. Other sprinkler system supervisory functions, such as dry pipe/pre-action system hi-low air pressure monitoring, must be on individual circuits.

The room's housing sprinkler control valves will be marked with a white sign with red letters stating, "Sprinkler Controls Inside". All sprinkler control valves shall be numbered and identify what section of the sprinkler it controls.

Inspector's test valves will be located at the highest point and whenever possible, piped to ground level and outside of the building with the appropriate 1/2" test fitting installed on the end of the pipe. Test valve discharge will not flow onto or across any sidewalk, stairs or public walkways.

Post indicator valves will be provided for each sprinkler system. Post indicator valve control shall be tied into the Fire Alarm Control Panel (FACP) on a separate module and wired in such a manner as to activate the "Trouble Alarm".

Standpipe flow switches shall be tied into the FACP on a separate module and wired in such a manner as to activate the "General Fire Alarm". Each standpipe flow switch will be provided with a spring loaded ball type check valve or an integral 15 to 20 second time delay device to prevent nuisance alarms from surges in water pressure.

Standpipe tamper switches shall be tied into the Fire Alarm Control Panel on a separate module and wired as to activate the "Trouble Alarm". The operation of the tamper switch shall not affect the operation of the flow switch and shall not activate the General Fire Alarm.

Standpipe control valves shall be enclosed in a cabinet or room and clearly marked by a white sign with red letters stating, "Fire Department Use Only". Standpipe fire hoses will not be installed in the hose cabinets; however, each standpipe connection must match District of Columbia Fire Department threads and diameter.

Systems with associated backflow preventers shall be tested as described in Division 22.

The use of dissimilar metals within piping systems is prohibited. Exceptions require Facilities Management approval and are limited to die-electric fittings only such as when existing material incompatibilities are discovered during renovations.

KITCHEN EXHAUST HOOD EXTINGUISHING SYSTEMS

Systems shall be interconnected with the fire alarm, on a dedicated zone. The exhaust fan must continue running after the system has been discharged to remove smoke, but the supply fan serving the space with the hood shall stop.



Appliances under the kitchen hood must have their gas or electric fuel automatically shut off upon agent release. Both of these functions are normally performed directly by the extinguishing system, through mechanical linkage to the gas valve or via internal microswitches controlling shunt trip breakers. All shut down devices shall require manual reset prior to fuel or power restoration.

Initiation devices shall be fusible link rather than electrical devices for standardization of hood suppression systems, reduction of maintenance costs and to simplify training for emergency response personnel. University Safety and Security Services has approved the following suppression system for installation in Campus facilities:

A "Puff Test" shall be performed and witnessed by AU Fire Safety personnel and District of Columbia Fire Marshall.

The contractor shall perform maintenance and adjustments for the duration of the substantial completion warranty. Coordinate with Facilities Management Life Safety Manager prior to performing any work. All routine maintenance and service must be scheduled two-weeks in advance and will be supervised by University personnel.

Integration with the Building Automation System and commissioning testing is required for all kitchen exhaust hood systems. Refer to additional alarm and connection requirements in Division 25.

END OF DIVISION 21



DIVISION 22 PLUMBING

GENERAL

The Consultant shall provide a written description of how the entire system is designed to operate. This Basis of Design (BOD) narrative also shall describe how project objectives are being met. It shall be provided in a format that can be easily understood by a lay person, the end user. The narrative shall identify items that specifically meet the University's Project Requirements (OPR) and the most recent Facilities Management (FM) or department System Master Plan(s) and articulate a rationale for any variance.

For renovations, the systems selected shall be compatible with the existing building's mechanical and plumbing systems. The integrity of the basic existing building system shall not be compromised, except where agreed to by the University. Work shall be designed and sequenced to minimize impact and interruptions in occupied buildings. Consult with FM to identify the timing necessary for notifications and operational requirements (e.g. after hours work, backup systems, or field support).

For site work, the Consultant shall indicate all existing such as piping, valves, manholes, electric wiring and telephone underground work using the latest American University (AU) utility plan, whether new connections are being made or not. Profiles of all new storm and sanitary sewers need to be shown to facilitate coordination with the crossing of other utilities.

The Consultant shall incorporate any requirements from the University insurance carrier or Risk Management into the design and specifications.

PLUMBING, DOMESTIC AND SANITARY SYSTEMS DESIGN CRITERIA

The Consultant shall allow for normal expansion and contraction of the piping system. In addition to construction drawings, the project as-built drawings shall indicate expansion joints or pipe swings where designed or added.

All fluid systems shall be designed to be fully drainable.

American University is committed to energy efficiency and water use reduction. Designers should consider water reduction methodologies if applicable for incorporation into the project. Do not discharge water-cooled equipment to drains.

Metering at the campus level and/or sub-metering at the building level is required. Meter records (size, purpose) along with a photograph of the installation with the meter number clearly shown shall be submitted to FM Energy and Engineering (E&E) when placed in service.



Meters associated with billing are required to be supplied by DC Water. This applies to domestic, irrigation, cooling tower makeup or similar applications. Sub-meters for irrigation and cooling towers should be programmed by DC Water to receive sewer credit on the utility bill.

Plumbing design shall be compatible with the latest version of the local energy code(s) as amended to include water conservation requirements. Energy conservation measures shall be incorporated into all projects.

Piping and plumbing equipment design and selection shall allow for anticipated future building expansion. The need for expansion should be discussed during the project design phase. The Consultant shall evaluate piping that might be subject to freezing and provide proper freeze protection as necessary.

Water or sanitary piping will not be allowed in telephone rooms, electric equipment rooms and closets, elevator machine rooms, emergency generator rooms or over motor control centers. In addition, sanitary drainage piping shall not be run at the ceiling of any food-preparation or serving area.

Water (and gas piping) shall not be run under buildings where access is not readily available except where necessary to pass through the exterior wall of a building and then immediately turn up into the building.

The following flow and flush rates are required minimums for all new and replacement plumbing fixtures. Indoor plumbing renovations must include plumbing fixture replacements compliant with the flush and flow rates below as a minimum or as required by local code, whichever is more stringent.

AU Plumbing Fixture Flow Rate Chart

Fixture	Flow / Flush Rate
Water closet	1.28 / .08 GPF dual flush
Urinal	0.125 GPF (pint flush) urinal
Lavatory faucet	0.5 GPM
Kitchen / janitorial sink	2.2 GPM
Shower	1.5 GPM

Where options exist for low flow rates for other fixtures, the lowest flow rate should be selected. Fixtures that exceed the flow rates above should be submitted for approval as an exception and will be considered only on a case-by-case basis.

The design of plumbing systems should consider serviceability of equipment, valves and accessories and isolation for repairs. Vents and drains shall be identified on the drawing. Design drawings should include a detail showing piping size, valve and hose connection. For large projects, isometric piping diagrams shall be included in the



drawings. Drains shall route to the closest or readily accessible drain in a manner to prevent a tripping hazard. System and branch drains located within areas occupied by non-FM departments should be avoided.

Orient valves, gages and indicators so that position is visible from the floor level without ladder use.

Backflow preventers shall be certified within one (1) week of occupancy with a copy of the required forms and printout formally transmitted to Facilities Management.

Include trap primers for drains in interior locations including under equipment, within restrooms and wash down areas. Mechanical rooms and locations with infrequent use shall have drain trap primers. Trap guards are acceptable on renovations to existing buildings not new construction.

The placement of cleanouts shall consider maintenance equipment requirements such as drain snakes or inspection cameras. Identify on drawing distance requirements and confirm access to a water source with hose bibb and a dedicated electric receptacle. Fixture removal as a cleanout should be the last resort and avoided if possible. All sanitary piping cleanouts shall be installed facing non-occupied spaces (i.e. hallways, corridors, etc.).

Equipment naming and labeling shall be consistent with other University systems and used consistently throughout the project., refer to the Equipment Naming Scheme document in the references section at www.american.edu/standards and related control naming document in Section 25 55 00.13 Control of HVAC Object Naming Convention. Submit equipment schedule during design phase for confirmation of the FM AiM asset identification. Include on drawings across all disciplines. See Division 26 for required color-coding of labels for equipment and components based upon energy source

Do not design a system that uses Victaulic or similar gasketed pipe for primary or secondary domestic hot water distribution within the building.

PVC piping is acceptable only for non-potable water applications such as condensate or similar applications. PVC pipe jacketing is not to be installed on the roof; only aluminum pipe jacketing is acceptable for exterior process piping.

On each floor, cold-water hose bibb connections are to be provided in a janitor's closet or if not feasible in discrete locations inside a lockable (2BB key) hose bibb box.

Roof mounted equipment condensate and/or service drains will not be permitted over sensitive spaces. If not possible, oversize drain size to prevent flooding.

Install one (1) hose bibb on each side of a building, as well as one (1) on the roof for equipment requiring cleaning or vegetative roofing.



Projects using BIM modeling shall detail all manufacturer's requirements for equipment service clearances.

Specialty plumbing equipment are to be purchased with an associated minimum two-year warranty on parts and labor. Examples include acid neutralization, vacuum pumps, air compressors, etc.

Type L copper piping is required for domestic water piping distribution. Type M copper is not acceptable.

The use of t-drill as an installation method on 2 inch and larger piping is acceptable.

Pro-press as a connection is allowed in accessible areas only and shall be so noted on the as-built drawings. FM possesses a complete Pro-press kit for maintenance purposes for sizes up to 4 inch; other manufacturers will not be considered.

All wastewater, injectors and sump pump pits and assemblies to have odor free lids and gasketing to manage odor. Include pump lift mechanism on pits exceeding three (3) feet. Sump pump must report and alarm to the Building Automation System and have associated graphics.

Test potable water systems per local code and utility requirements. Provide test and acceptance results to FM prior to occupancy or use.

Dielectric nipples are not allowed. On an independent chart (similar to the valve chart), all installed dielectric connections are to be documented. Laminate and post in closest mechanical room. Submit electronic version of posting in Excel and PDF during close-out.

All exterior utility tie-ins shall include a manhole for ease of operation, service and maintenance.

BUILDING AUTOMATION SYSTEM REQUIREMENTS – DIVISION 25

During design development, submit for compatibility review a complete manufacture points list for controlled equipment provided under this Division, indicating if points are monitor-only or capable of remote control. Point mapping to the existing BAS system is an owner requirement. Variances require concurrence of Facilities Management.

Include a complete description of technical control requirements such as handheld devices needed for field adjustment, software and licensing (proprietary or open source), or gateway requirements. Refer to Division 25 for building automation requirements.

Packaged pumps and specialties, skid mounted are preferred over field-assembled units with components from multiple manufacturers. Integration with Building



Automation System (BAS) for monitoring, control and alarms shall follow the BAS Master Plan and the requirements listed in Division 25.

COMMISSIONING OF PLUMBING SYSTEMS – 22 08 00

In addition to required startup and performance testing, plumbing systems shall follow the connectivity and alarm requirements as described in the Building Automation Master Plan and the FM Commissioning Plan. See Division 1, Section 01 91 13 and Division 25. Additional requirements by DC Green Code may also apply.

COMMERCIAL PLUMBING FIXTURES – 22 41 00, 22 42 xx

For residence halls and high-traffic areas, low-flow toilets must incorporate a pressure-assisted technology (as opposed to the standard gravity-fed option).

Automatic flush valves shall be hardwired, not battery or wireless. Turbine or electrically powered with battery backup are to be used.

All fixtures and appurtenances should be selected based upon having a local (DC Metro area) manufacturer's representative and supplier.

HEAT TRACING – 22 04 29

Integrate heat tracing into the Building Automation System as a start/stop status point and alarm on failure to operate based upon Outside Air Temperature (OAT).

VALVES

Valves used for isolation and control shall provide absolute shut-off to full ANSI Class ratings with pressure in either direction, allowing flexibility in system design and utility during system maintenance.

The height preference for valve handle access is less than five (5) feet or as required by code. Valve handles over eight (8) feet shall have a chain operator or similar device. The same applies to installed access panels. Refer to Division 23 for size requirements.

Isolation valves to be high performance bubble free and required for all ball valves and butterfly valves 2 inches and larger.

Stainless steel is preferred for valve bodies, seats, retainers and associated packing gland retainer studs. Bearings shall be stainless steel with PTFE/fiberglass mesh liner. Composite materials shall not be used.

Valve tags are to be installed down to one-inch pipe. Valve charts are to be laminated



and kept accordingly in the closest mechanical rooms or floor service closets. Note that FM and University Housekeeping do not share access to the same service spaces and charts must be FM accessible.

During project closeout, the first fifteen (15) feet of sanitary and storm piping for all new roof and floor drains shall be bore scoped. Pipe condition documentation to be sent as a closeout submittal.

VALVES, BALL – 22 05 23.12

Valve selection criteria is chromium plated or stainless steel (full port) ball valve. Performance rating is minimum 400 psi CWS, 125 SWP with 600 WOG preferred and maximum temperature of 400F.

Where insulation is specified, provide factory installed extended stems to receive insulation. Service valves installed in systems below ambient temperature shall have Therma-Seal as manufactured by Apollo or approved equal.

Chain wheel operators shall be provided for all valves 2-1/2" or larger installed 72 inches or higher above finished floor. Extend chains to an elevation of 60 inches above finished floor.

Hand wheels fastened to valve stem shall be provided for valves other than quarter-turn types. Lever handles shall be provided for quarter turn valves 4" and smaller.

Gear drive operators shall be provided for quarter turn valves 6" and larger.

VALVES, BUTTERFLY – 22 05 23.13

Valve selection criteria is high performance positive shutoff on pressure or vacuum with zero leakage and bubble tight for all isolation valves over 2 inches. All shafts shall be one-piece construction.

VALVES, CHECK – 22 05 23.14

Standard swing check valves over 4" shall be rubber faced. Resilient coatings such as ethylene propylene diene monomer rubber (EPDM) or porcelain may also be appropriate.

Install check valve with a minimum of 5 (five) pipe diameters downstream from any flow disturbance (valve, pump, elbow or reducer) to reduce chatter and early valve failure.

VALVES, GATE – 22 05 23.15

Valve selection criteria is adjustable packing gland, blow out proof stem design, with



polytetrafluoroethylene (PTFE) seats and ethylene propylene diene monomer rubber (EPDM) stem packing.

Standard steel wedge type gate valves should be outside screw and yoke, rising stem, non-rising hand wheel, and bolted bonnet.

Gate valves are to be used in specific installations only with prior approval from FM. Do not use where dirty surface medium may cause seating problems.

WATER FOUNTAINS AND WATER COOLERS – 22 47 10, 22 47 13

All drinking fountains must accommodate a refillable water bottle. Fountains that accommodate reusable water bottles come at two price points, glass fillers and bottle filling stations. The filling stations have advantages with speed, visibility, sanitation, and vandalism prevention; however, they are more expensive. Type, including cost and frequency of fillers, is a prime selection criterion. Water bottle filling units should have a filter alarm and show calculation of disposable containers avoided.

New buildings are required to have water bottle filling stations. During renovation projects, water fountains must either be replaced with filling stations or modified with glass fillers in low traffic areas.

Fillers must have a feature that shuts off the water supply if the filler is disconnected.

EMERGENCY PLUMBING DESIGN REQUIREMENTS

In an area where eyewash equipment is required, the eyewash station must be designed to the following specifications:

- The eyewash must be plumbed and provide potable, tempered water between 60°F and 100°F, with an ideal sustained temperature of 85°F.
- Equipment must be made of stainless steel and/or high impact plastic.
- The eyewash must be able to be activated in one second or less and stay activated without further use of the operator's hands. It must stay activated until manually shut off.
- Nozzles must have caps that protect them from airborne contaminants. The caps must automatically discharge upon activation without additional operator effort.
- The eyewash must deliver at least 0.4 gallons of water per minute.
- The water pressure should be 30 psi.
- Exposed piping subject to damage must have PVC jacketing.
- Outdoor units must be equipped with freeze protection.

Hand-held emergency drench hoses are not acceptable alternatives to plumbed. It must stay opened without further use of the operator's hands. It must stay activated until manually shut off.

- The eyewash must deliver at least 20 gallons of water per minute.
- The water pressure should be 30 psi.
- At a height of 60 inches above the floor, the spray pattern must be at least 20 inches in diameter.
- Water service to the shower must be equipped with a ball valve and lever handle. The valve must be accessible with a 6-foot ladder to provide shut-off capability in order to service the fixture. The valve's handle shall be able to be turned/manipulated without the need for tools or equipment. A single valve shall serve to shut of both the hot and cold water.
- Exposed piping subject to damage must have PVC jacketing.
- Outdoor equipment must be equipped with freeze protection.

EMERGENCY PLUMBING FIXTURES - 22 45 00

The need to install a safety shower or eyewash is dependent upon the planned use of the space. All new construction and renovation projects that require installation of a safety shower or station must ensure that the equipment complies with the most recent ANSI Z358.1 standard. Final design approval should be obtained from the Risk Management office.

All installations shall meet the following standards:

- ANSI Z358.1 (most recent publication)
- OSHA – 29 CFR 1910.151(c)
- Americans with Disability Act of 1990

EMERGENCY SHOWERS – 22 40 00

An emergency shower is required in any area that contains or will contain more than 2.5 liters of caustics or corrosives that could cause injury to the skin or eyes. The product's Safety Data Sheets should be reviewed for any language that refers to the substance as an "injurious corrosive." Some examples of areas that require eyewash equipment are battery changing or charging stations, wet laboratories, pesticide mixing stations, chemical or pesticide storage areas, and fine art studios.

A sign shall be placed above each emergency shower that reads "Emergency – Safety Shower" and contains the safety shower symbol. The background may be white or green with black or white writing. The sign must be large enough and placed high enough above the station so that it can be easily seen and read from anywhere within the immediate space.





CONFIGURATION

- The shower may not be located directly over or within three feet of electric power sources such as outlets, switches or power supply panels, regardless of whether or not they are Ground-Fault Circuit Interrupted (GFI).
- The center of the showerhead must be at least 24 inches away from obstructions (walls, benches, etc.)
- The activation pull shall not be more than 69 inches from the floor.
- The activation pull must be located out of the normal pathway in the room to minimize the likelihood of accidental activation, preferably within two inches of a wall or bench.
- The shower may not be obstructed by other permanent or temporary structures.
- Strainers are recommended in the hot and cold water lines ahead of the tempering valves and eyewashes or showers.
- The showerhead shall be between 82 and 96 inches from the floor.
- It is preferred that the shower be located near a floor drain, and the floor shall be sloped toward the drain. Floor drains with removable plugs are acceptable. For units not plumbed to a drain, the waste connection must point away from the wall.

EYEWASH EQUIPMENT – 22 45 16

An emergency eyewash station is required in any area that contains or will contain caustics or corrosives that could cause injury to the eyes. The product's Safety Data Sheets should be reviewed for any language that refers to the substance as an "injurious corrosive." Some examples of areas that require eyewash equipment are: battery changing or charging stations, wet laboratories, mechanical spaces, housekeeping storerooms, theater set design studios, photography dark rooms, chemical or pesticide storage areas, and fine art studios.

Hand-held eyewash bottles and self-contained eyewash stations are not acceptable alternatives to plumbed eyewash units.

In an area where eyewash equipment is required as stated above, the eyewash station must be placed as follows:

- Eyewashes should be accessible within 10 seconds from any point in the work area, with the maximum travel required being 50 feet.
- If the eyewash station cannot be reached within 10 seconds or 50 feet, whichever is less, another eyewash station must be installed.
- The eyewash station must be present within the same contiguous area as the hazard. It must be positioned such that the user does not have to travel to a different room to use.
- The eyewash unit may be combined with safety showers or sink-mounted, as long as it still meets the design requirements discussed below.

A sign shall be placed above each eyewash station that reads “Emergency – Eye Wash Station” and contains the eyewash symbol. The background may be white or green with black or white writing. The sign must be large enough and placed high enough above the station so that it can be easily seen and read from anywhere within the immediate space.



CONFIGURATION

- The eyewash may not be located directly over or within three feet of electric power sources such as outlets, switches or power supply panels, regardless of whether or not they are Ground-Fault Circuit Interrupted (GFI).
- The eyewash must be installed with sufficient space to allow the user to hold their eyelids open with both hands while the eyes are being rinsed
- Nozzles should be positioned between 33 and 45 inches from the floor, and at least 6 inches from the wall or nearest obstruction. The nozzles must be easily accessible to the operator with no obstructions. Combination drench hose/eyewash units must be positioned so that the eyewash can be activated without having to manipulate the drench hose.
- Strainers are recommended in the hot and cold water lines ahead of the tempering valves and eyewashes or showers.
- The eyewash should be located above a sink or floor drain. For units with a waste connection that is not plumbed to a drain, the waste connection should point away from the wall.

SELF-CONTAINED EYEWASH EQUIPMENT – 22 45 19

Self-contained eyewash equipment may not be used in new construction or major renovation projects. Self-contained eyewashes may only be used in areas that have changed occupancy but have not undergone renovation.

The University Safety and Security Services office must be notified prior to the installation of a self-contained eyewash station.

HANDHELD EMERGENCY DRENCH HOSES – 22 45 29

A hand-held emergency drench hose may serve as an additional piece of safety equipment but may not replace an emergency shower where one is required. Refer to section 22 45 13 to determine if a safety shower is required.

END OF DIVISION 22



DIVISION 23 HEATING, VENTILATION AND AIR CONDITIONING

For all new construction and renovation projects, the Mechanical and HVAC design shall comply with applicable local and state codes and with the latest codes and guidelines of the following organizations:

- a. American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE)
- b. American National Standards Institute (ANSI)/ASHRAE 62.1 Ventilation for Acceptable Indoor Air Quality
- c. Sheet Metal and Air Conditioning Contractors National Association (SMACNA) Standards for Ductwork Design
- d. ANSI/American Industrial Hygiene Association (AIHA) Z9.5 Laboratory Ventilation
- e. ANSI/ASHRAE 110 Method of Testing Performance of Laboratory Fume Hoods
- f. American Society for Testing and Materials (ASTM)
- g. National Fire Protection Association (NFPA)
- h. National Electrical Code (NEC)
- i. National Electrical Manufacturers Association (NEMA)
- j. Occupational Safety and Health Administration (OSHA)
- k. American Society of Mechanical Engineers (ASME)

DESIGN CRITERIA

The Consultant shall provide a written description of how the entire system is designed to operate. This Basis of Design (BOD) narrative also shall describe how project objectives are being met. It shall be provided in a format that can be easily understood by a layperson, the end user. The narrative shall identify items that specifically meet the Owners Project Requirements (OPR) and the most recent Facilities Management (FM) or department System Master Plan(s) and articulate a rationale for any variance.

For renovations, the systems selected shall be compatible with the existing building's mechanical systems. The integrity of the basic existing building system shall not be compromised, except when agreed to by the Owner. Work shall be designed and sequenced to minimize impact and interruptions in occupied buildings.

For site work, the Consultant shall indicate all existing underground work such as piping, valves, manholes, electric wiring and telephone, whether new connections are being



made or not. Profiles of all piping need to be shown to facilitate coordination with the crossing of other utilities. Planning and Project Management or the Project Manager will provide existing campus utility information so new work can be coordinated.

The Consultant shall incorporate any requirements from the University insurance carrier or Risk Management into the design and specifications.

The Consultant shall allow for normal expansion and contraction of the piping system. In addition to construction drawings, the project as-built drawings shall indicate expansion joints or pipe swings where designed or added.

All fluid systems shall be designed to be fully drainable.

Specialty HVAC equipment is to be purchased with an associated minimum two-year warranty on parts and labor to begin on the same day as Final Acceptance. Examples include boilers, chillers, vacuum pumps, air compressors, etc.

Mechanical equipment rooms shall be placed preferably at ground level and away from occupied spaces to minimize transmission of noise vibrations into the building.

During design development, submit for compatibility review a complete manufacture points list for controlled equipment provided under this Division, indicating if points are monitor-only or capable of remote control. Point mapping to the existing BAS system is an owner requirement and must comply with AU Division 25 integration requirements. Variances require concurrence of Facilities Management.

Include a complete description of technical control requirements such as handheld devices needed for field adjustment, software and licensing (proprietary or open source), or gateway requirements. Refer to Division 25 for building automation requirements.

MECHANICAL SYSTEMS AND ENERGY CONSERVATION

The minimum accepted standards for energy conservation as described in the District of Columbia Building Code will not only be met, but exceeded, where possible. Life cycle cost/present worth analysis that assesses the total cost of a system over its entire useful life will be used and is required on Capital Projects.

Building areas that require 24-hour-per-day occupied HVAC operation, such as libraries, security stations, and laboratories, shall be served by a system separate from those that can apply unoccupied schedules for energy savings. Typical areas with occupied and unoccupied schedules include offices, classrooms, and conference spaces.

The Consultant will incorporate energy reduction strategies in place at American University into the design. These include, but are not limited to, demand control ventilation, occupied/unoccupied mode, automated demand response, and campus



closure.

Energy recovery shall be incorporated for all single pass 100% outdoor air systems.

Areas with unique load off-season or beyond system loop piping capacity typically require supplemental cooling.

PACKAGED (FACTORY) CONTROLLERS

All equipment designed to be sequenced by a factory or packaged controller must adhere to the controller and integration requirements of Division 25.

- A. Design Phase Requirements: During the design phase, any package controller equipment or system shall be identified for review by AU. AU will provide review comments to the design team regarding controller requirements. Identify opportunities where equipment and systems can be sequenced from a packaged controller or BAS DDC controller.

When the equipment or system controller is defined in the design documents, the design team will be required to include the following:

- 1) Input/Output Matrix – Table listing the required operating points, including alarm information, hardwired points list, description of the point, and the tag ID. (This list should include ONLY the points being used to sequence or monitor the equipment or system in question.)
 - 2) Control diagrams showing connections from the packaged system or equipment controller to the AU BACNET network or gateway.
 - 3) Associated Sequence of Operations
- B. Construction Submittal Phase: The controls contractor will submit the following:
- 1) Controller IOM: The document, as provided by the manufacturer, including BACnet protocol for open communications, list of inputs/outputs, wiring diagram and complete point database with the following:
 - a. Point number
 - b. Descriptor
 - c. Factory default point units and range
 2. Equipment/System IOM:
 - a. Contact information for manufacturer's rep for service calls and maintenance.
 - b. Reference product data for package controller
 3. Finalized stand-alone points list with alarm information
 - a. Analog High Alarm
 - b. Analog Low Alarm
 - c. Digital Alarm Condition
 - d. Alarm Delay
 - e. Alarm Priority



- f. Conditions that Trip and/or Reset Alarms
 - g. Units
- C. Construction Installation: Manufacturer's representative, controls contractor and CM/GC representative will provide completed pre-functional and installation startup documentation prior to completion of installation work.

This PFC documentation will be reviewed by the Owner's BAS department and the Owner's Commissioning Agent for compliance with the pre-functional checklist and manufacturer's provided installation and startup materials.

- D. Functional Testing: During Commissioning Agent led functional testing, both the manufacturer's representative and the controls contractor shall be present on site to complete the approved functional test script under supervision of the Owner's Commissioning Agent.

All issues and deficiencies found during functional testing shall be addressed prior to turnover and wrap up of controls work for that system or equipment. Testing shall also include a dry run utilizing all available points, alarms and sequences associated with the packaged controller to ensure compliance with the design documents.

- E. Post Construction and Closeout: Once the controls work has concluded and all functional tests have passed, the manufacturer will submit to the CM/GC a complete turnover package that includes the following:
- 1) List of stand-alone points formatted in MS Excel with filters in place for sorting the list by name, point type or address.
 - 2) Final I/O Matrix with complete point list.
 - 3) Final O&M manual with a table of contents and bookmarks.
 - 4) Final updated submittal with any changes to points, sequences or alarms noted in a red-lined format.
 - 5) Final control diagrams with any changes to point or controller layout noted in a red-lined format.
 - 6) Final warranty document with complete contact list for service calls.

This final closeout package will be reviewed by the CM/GC for compliance with the project documents before being distributed to the Owner for review and approval.

CHILLED WATER RELATED DESIGN CRITERIA

The preferred cooling medium for air conditioning systems is chilled water. Spot cooling data closets and similar areas where chilled water is not continuously available may be accomplished with split systems.

For renovation projects, the Consultant shall verify that the existing chilled water system capacity will support the new load. Renovations to existing chillers and towers shall require detailed scheduling to minimize any potential loss of cooling to the building.



New systems connecting to a campus chilled water loop shall use a plate and frame heat exchanger between the building and the central chilled water loop. Chilled water systems and related terminal equipment shall be designed for a minimum 12-degree temperature differential based upon 45-degree entering water temperature.

To meet winter cooling loads, a waterside economizer may be employed where the use of 100% outdoor air is not possible. Plate and frame heat exchangers are strongly recommended for this application. Use of a side stream filter is strongly recommended for the cooling tower side of the system.

Special attention shall be paid to fresh air requirements for ventilation. Criteria for minimum fresh air shall follow the latest ASHRAE guidelines adopted by the District of Columbia. Consideration should be given to demand ventilation or on-demand I.A.Q. through use of environmental measurements including CO2 sensors. Refer to current ASHRAE guidance regarding IAQ assessment.

To satisfy system requirements for outdoor air, a dedicated minimum outside air damper is preferred for air-handling units.

The location of outside air intakes shall be chosen for proper separation from any exhaust outlets to prevent cross contamination.

Air conditioning systems should make use of re-circulated air from spaces where no air contamination exists, such as offices and classrooms.

HEATING WATER RELATED DESIGN CRITERIA

American University owns and operates a Low Temperature Hot Water System (LTHW) that provides district heating for the Main Campus. The heating demand for any new construction or renovation shall be submitted to E&E for verification of whether the existing

LTHW distribution system will be adequate to meet the new demand and the nature of required piping and flow adjustments, system balancing and equipment recalibration.

New systems connecting to the main campus LTHW system are to be designed to work with low temperature hot water of 150 degree entering water temperature without the use of secondary heating systems.

MECHANICAL EQUIPMENT ROOMS

Provide thermostatically controlled ventilation as required.

The system design should be such that it meets the needs of the application. The Consultant shall select equipment that is consistent with the design and application of the system. Mechanical systems shall be designed to accommodate reasonable future



functional space changes.

Paint equipment curb risers safety yellow.

The designer should review and incorporate supplemental information on specifics for type of room use found in the Facilities Management Space Needs document, listed in the References section of the Standards.

SOUND AND VIBRATION CONTROL

Outdoor equipment such as cooling towers, fans, and air-cooled condensers shall not produce noise levels that will exceed the interior and exterior dB levels defined in the Owner's Project Requirements. The dB level required to meet this goal shall be specified and included on the project documents and drawing schedules.

HVAC equipment located in the building shall be carefully evaluated for sound level. If sound levels are expected to be higher than recommended in ASHRAE 'Noise and Vibration' guidelines, sound control devices are required.

Room terminal units such as variable volume terminals shall be selected for low sound levels. Air supply diffusers and registers shall have sufficiently low air velocity to meet low sound criteria. Air noise from a supply outlet that exceeding the dB levels established in the Owner's Project Requirements is not acceptable.

Appropriate vibration isolation of equipment, piping and ductwork shall be specified.

VALVES

Ball valves are to be used in lieu of butterfly valves if size permits. For control valves use only ball valves that are characterized, equal percentage V-port.

Valves used for isolation and control shall provide absolute shut-off to full ANSI Class ratings with pressure in either direction, allowing flexibility in system design and utility during system maintenance.

Valve tags are to be installed down to one-inch pipe size. Valve charts are to be laminated and kept accordingly in nearest mechanical rooms or floor service closets. Note that FM and University Housekeeping do not share access to the same service spaces.

Stainless steel is preferred for valve bodies, seats, retainers and associated packing gland retainer studs. Bearings shall be stainless steel with PTFE/fiberglass mesh liner. Composite materials shall not be used.



VALVES, BALL – 23 05 23.12

Valve selection criteria is chromium plated ball or stainless steel (full port). Performance rating is minimum 400 psi CWS, 125 SWP with 600 WOG preferred and maximum temperature of 400F.

Where insulation is specified, provide factory installed extended stems to receive insulation. Service valves installed in systems below ambient temperature shall have Therma-Seal as manufactured by Apollo or approved equal.

Chain wheel operators shall be provided for all valves 2-1/2" or larger installed 72 inches or higher above finished floor. Extend chains to an elevator of 60 inches above finished floor.

Hand wheels fastened to valve stem shall be provided for valves other than quarter-turn types. Lever handles shall be provided for quarter turn valves 4" and smaller.

Gear drive operators shall be provided for quarter turn valves 6" and larger.

VALVES, BUTTERFLY – 23 05 23.13

Valve selection criteria is high performance positive shutoff on pressure or vacuum with zero leakage and bubble tight for all valves over 2 inches. All shafts shall be one-piece construction.

VALVES, CHECK – 23 05 23.14

Standard swing check valves over 4" shall be rubber faced. Special coatings such as ethylene propylene diene monomer rubber (EPDM) porcelain may also be appropriate.

Install check valve with a minimum of 5 (five) pipe diameters downstream from any flow disturbance (valve, pump, elbow or reducer) to reduce chatter and early valve failure.

VALVES, GATE – 23 05 23.15

Valve selection criteria is adjustable packing gland, blow out proof stem design, with polytetrafluoroethylene (PTFE) seats and ethylene propylene diene monomer rubber (EPDM) stem packing.

Standard steel wedge type gate valves should be outside screw and yoke, rising stem, non-rising hand wheel, and bolted bonnet.

Gate valves are to be used in specific installations only with prior approval from FM. Do not use where dirty surface medium may cause seating problems.



HEAT TRACE FOR HVAC – 23 05 33

Electric cables for freeze protection shall be on independent circuits and supplied by emergency power when available. System status shall be monitored by the building automation system and alarm based upon outside air temperature requirement when not energized.

IDENTIFICATION FOR HVAC – 23 05 53

Equipment naming and labeling shall be consistent with other University systems and used consistently throughout the project. Submit equipment schedule during design phase for confirmation of the FM AiM asset identification. Include drawings across all disciplines. See Division 26 for required color-coding of labels for equipment and components based upon energy source and the references section of this document for the naming scheme. Coordinate with Section 25 55 00.13 for integrated automation control naming consistency.

COMMISSIONING FOR HVAC – 23 08 00

In addition to required startup and performance testing, HVAC systems shall follow the connectivity and alarm requirements as described in the Building Automation Master Plan and the FM Commissioning Plan. See Division 1, section 01 91 13 and Division 25. Additional requirements by DC Green Construction Code may also apply.

DDC SYSTEM FOR HVAC – 23 09 23, 23 09 93

American University has standardized its automated building control systems. The standard specifications shall be incorporated for all projects. The standardization of building control systems does not relieve the Consultant from providing schematic control diagrams and descriptions of the sequence of operation for all systems. Refer to and incorporate Division 25 requirements along with any supplemental information in the current Building Automation Master Plan and suggested control drawings with sequences.

HYDRONIC PIPING – 23 23 13

The use of t-drill as an installation method on 2 inch and larger piping is acceptable.

Pro-press as a connection is allowed in accessible areas only and shall be so noted on the as-built drawings. FM possesses a complete Pro-press kit for maintenance purposes up to 4-inch diameter, other manufactures will not be considered.

Do not design a system that uses Victaulic or similar gasketed pipe for primary or secondary heating or cooling distribution within the building. The exceptions are readily accessible mechanical areas, equipment connections and fire suppression.



The use of die-electric isolating nipples is not allowed.

HYDRONIC SYSTEM TREATMENT – 23 25 00, 25 25 13, 23 25 16

Compatibility with the current E&E treatment program is required. Information on treatment and tie-in requirements is provided in the References section of this document. Treatment system acceptance by FM will require documentation from contractor verifying flushing, passivation and treatment by the AU chemical contractor using components and supplies from the vendor.

ENERGY METERS – 23 0923

American University is committed to energy efficiency and confirming system performance. Thermal metering is required using equipment compatible with and integrating fully with the building automation system and the existing data collection program. For meters residing on the BAS sub-network this typically requires a 4-20mA, 0-10VDC, or BACnet-MS/TP connection. For meters outside the BAS sub-network communication should be through TCP/IP Modbus or BACnet Object. Confirm specific requirements and placement with E&E Energy Manager.

AIR DUCT SPECIALTIES – 23 33 00

Contractor will have a third party inspect and verify that smoke and fire dampers are installed per manufacturer's requirements, are readily accessible for maintenance, and meet required performance. Third party inspector shall be ICB certified and acceptable to inspect and test smoke and fire dampers by the Authority Having Jurisdiction.

Inspect prior to acceptance at the 100% rate, no sampling allowed, with Commissioning Agent or University designee and at one-year interval as per NFPA 105 and NFPA 80 requirements. All dampers must pass inspection.

END OF DIVISION 23



DIVISION 25 INTEGRATED AUTOMATION

The Facility Management Energy and Engineering (E&E) unit has developed a Building Automation System (BAS) guideline standard that is comprised of the technical information and control strategies utilized at the University. All projects with a BAS component are expected to seamlessly connect with the campus wide BAS as defined in the guideline. No BAS should be designed as a stand-alone or local control system.

Consultants and designers are expected to apply the BAS guideline standards to include coordination of Division 22, 23, 25, and 26 equipment/systems included in the project.

The Building Automation unit of Energy and Engineering has also prepared template equipment control drawings and sequences that follow the BAS guideline. Example guideline documents are available upon request to E&E from Planning and Project Management or the assigned Project Manager in either pdf or dwg format.

Guideline sections included in the combined document are:

- 25 08 00 Integrated Automation Commissioning
- 25 11 13 Integrated Automation
- 25 11 16 Network Routers Bridges Switches Hubs and Modems
- 25 14 13 Remote Control Panels
- 25 15 16 Software for Control and Monitoring of Networks
- 25 35 00 Instrumentation and Terminal Devices for HVAC
- 25 35 11 Actuators and Operators
- 25 35 16 Sensors and Transmitters
- 25 35 19 Control Valves
- 25 55 00 Control of HVAC
- 25 55 00.19 Control of HVAC Object Naming Convention
- 25 95 00 Control Sequences for HVAC



SECTION 25 08 00 INTEGRATED AUTOMATION COMMISSIONING

GENERAL

1.01 SECTION INCLUDES:

- A. BAS and equipment testing and start-up
- B. Validation of proper and thorough installation of BAS and equipment
- C. Functional testing of control systems
- D. Documentation of tests, procedures, and installations
- E. Coordination of BAS training
- F. Documentation of BAS Operation and Maintenance materials

1.02 GENERAL DESCRIPTION

- A. This section defines responsibilities of the BAS Contractor to commission the BAS.

PRODUCTS

1.03 INSTRUMENTATION

- A. Instrumentation required to verify readings and test the system and equipment performance shall be provided by the Contractor and made available to the Commissioning Authority. Generally, no testing equipment will be required beyond that required to perform Contractor's work under these Contract Documents. All equipment used for testing and calibration shall be NIST/NBS traceable and calibrated within the preceding 12-month period. Certificates of calibration shall be made available when requested.

EXECUTION

1.04 STARTUP TESTING, ADJUSTING, CALIBRATION

- A. Work and/or systems installed under this Division shall be fully functioning prior to Demonstration and Acceptance Phase. Contractor shall start, test, adjust, and calibrate all work and/or systems as described below:
 - 1. Inspect the installation of all devices. Review the manufacturer's installation instructions and validate that the device is installed in accordance with them.
 - 2. Verify proper electrical voltages, amperages and verify that all circuits are free from faults.
 - 3. Verify integrity/safety of all electrical connections.
 - 4. Coordinate with TAB subcontractor to obtain the following control settings once TAB work is complete:
 - a) Optimum duct static pressure setpoints for VAV air handling units.
 - b) Minimum outside air damper settings for air handling units.
 - c) Optimum differential pressure setpoints for variable speed pumping systems.
 - d) Calibration parameters for flow control devices such as VAV boxes and flow measuring stations.
 - 5. Test, calibrate, and set all digital and analog sensing and actuating devices. Calibrate each instrumentation device by making a comparison between the



6. BAS/Local Control Display and the reading at the device. Record the measured value and displayed value for each device in the Start-Up Report.
7. Check and set zero and span adjustments for all transducers and transmitters. Excessive signal buffering is not acceptable, span adjustments must be within 2% of their respective end points. (i.e. Do not control a 2-10vdc actuator with a 0-10vdc signal; worst case signal should be 1.8-10.2vdc.)
8. For dampers and valves:
 - a) Check for adequate installation including free travel throughout range and adequate seal.
 - b) Where loops are sequenced, check for proper control without overlap.
9. For actuators:
 - a) Check to ensure that device seals tightly when the appropriate signal is applied to the operator.
 - b) Check for appropriate fail position, and that the stroke and range is as required.
 - c) For sequenced electronic actuators, calibrate per manufacturer's instructions to required ranges.
10. Check each digital control point by making a comparison between the control command at the CU and the status of the controlled device. Check each digital input point by making a comparison of the state of the sensing device and the Operator Interface display. Record the results for each device in the Start-Up Report.
11. For outputs to reset other manufacturer's devices (for example, VSDs) and for feedback from them, calibrate ranges to establish proper parameters.
12. Verify proper sequences by using the approved checklists to record results and submit with Start-Up Report. Verify proper sequence and operation of all specified functions.
13. Verify that all safety devices trip at appropriate conditions. Adjust setpoints accordingly.
14. Tune all control loops to obtain the fastest stable response without hunting, offset or overshoot. Record tuning parameters and response test results for each control loop in the Start-Up Report.
15. For interface and DDC control panels:
 - a) Ensure devices are properly installed with adequate clearance for maintenance and with clear labels in accordance with the record drawings.
 - b) Ensure that terminations are safe, secure and labeled in accordance with the record drawings.
 - c) Check power supplies for proper voltage ranges and loading.
 - d) Ensure that wiring and tubing are run in a neat and workman-like manner, either bound or enclosed in trough.
 - e) Check for standalone performance of controllers by disconnecting the controller from the LAN. Verify the event is annunciated at Operator Interfaces. Verify that the controlling LAN reconfigures as specified in the event of a LAN disconnection.
 - f) Ensure that all outputs and devices fail to their proper positions/states.
 - g) Check for adequate grounding of all BAS panels and devices.
 - h) Thoroughly clean interior and exterior of control panel per manufacturer



16. For Operator Interfaces:

- a) Verify that all elements on the graphics are functional and are properly bound to physical devices and/or virtual points, and that hot links or page jumps are functional and logical.
- b) Output all specified reports for review and approval.
- c) Verify that the alarm logging is functional and per requirements.
- d) Verify that trends are archiving to the CSS and provide a sample to the Commissioning Authority and Owner for review.

17. Verify proper interface with fire alarm system.

- B. Submit Start-Up Test Report: Report shall be completed, submitted, and approved prior to Substantial Completion.

1.05 SENSOR CHECKOUT AND CALIBRATION

- A. General Checkout: Verify that all sensor locations are appropriate and are away from causes of erratic operation.
- B. Calibration: Calibrate all sensors using one of the following procedures:
 1. Temperature, Humidity, CO₂, and CO Sensors: Make a reading with a calibrated test instrument within 6 inches of the site sensor at various points across the range. Verify that the sensor reading (via the permanent thermostat or gage) is within the tolerances specified for the sensor. If not, adjust offset and range, or replace sensor. Offset shall not exceed more than 5% of the sensor span. Where sensors are subject to wide variations in the sensed variable, calibrate sensor within the highest and lowest 20% of the expected range.
 2. Pressure Sensors: Disconnect sensor. With the equipment in normal steady state operation, override the control point to match the current control value (i.e. Lock the supply fan speed output to the current steady state value). Connect calibrated device in parallel with the pressure sensor(s). Make a reading with a calibrated test instrument. Verify that the sensor reading (via the permanent thermostat or gage) is within the tolerances specified. If not, replace the sensor and repeat. For pressure sensors, where steady state operation of the equipment cannot be maintained for calibration purposes, perform a similar process with a suitable signal generator.
- C. Sensor Tolerance: Sensors shall be within the tolerances specified for the device. Refer to Section 25 55 00.

1.06 COIL VALVE LEAK CHECK

- A. Verify proper close-off of the valves. Ensure the valve seats properly by simulating the maximum anticipated pressure difference across the circuit. Calibrate air temperature sensors on each side of coil to be within 0.5°F of each other. Via the Operator Interface, command the valve to close. Energize fans. After 5 minutes, observe air temperature difference across coil. If a temperature difference is indicated, and the piping surface temperature entering the coil is within 3°F of the water supply temp, leakage is probably occurring. If it appears that it is occurring, close the isolation valves to the coil to ensure the conditions change. If they do, this validates the valve is not closing. Remedy the condition by adjusting the stroke and range, increasing the actuator size/torque, replacing



the seat or replacing the valve as applicable.

1.07 VALVE STROKE SETUP AND CHECK

- A. For all valve and actuator positions checked, verify the actual position against the Operator Interface readout.
- B. Set pumps to normal operating mode. Command valve closed, verify that valve is closed, and adjust output zero signal as required. Command valve open, verify position is full open and adjust output signal as required. Command the valve to various few intermediate positions. If actual valve position doesn't reasonably correspond, replace actuator.

1.08 VERIFICATION TESTING

- A. Perform the following verification tests for each control system to ensure that the described control system components are installed and functioning per this specification.
- B. Verification test procedures, testing and activities shall be developed and conducted so as not to cause personal injury, damage to components, damage to systems, or damage the building or other property.
- C. General Requirements:
 - 1. Intent of the procedure is to demonstrate that the exact functions of control systems meet requirements outlined by approved shop drawings and written Sequence of Operation.
 - 2. Verify each air handling unit, equipment system, steam and hydronic system in automatic mode of operation, utilizing actual field devices and final control elements. Tune each control loop.
 - 3. Indicate type and cause of failures, as well as required remedial actions, on test report. Requested tests, not outlined herein, will be evaluated for feasibility and impact on schedule and cost prior to implementation.
 - 4. Systems will not be accepted by the Owner, CA or A/E without approval of tests and required remedial action.
 - 5. Provide a schedule to the Owner for execution of these tests. The Owner shall participate in any or all of the contractor's testing at the Owner's discretion.
 - 6. Provide all necessary BAS equipment and field adjustments to ensure that the HVAC equipment in the expansion and the base building operates to meet or exceed the acceptance criteria specified herein during all operating modes and HVAC related failure modes of the facility.
- D. Control System Static Check
 - 1. Prior to static check of system, identify each CU by description, tag number, and address. Verify proper system communication with these devices, as well as values indicated.
 - 2. Operational static check shall include verification of all field wiring associated with CUs. Include continuity testing between wiring from field device (sensor, actuator, or other components) to appropriate block on terminal strip in appropriate enclosure. Verify control loop wiring diagrams and panel wiring diagrams for the following:
 - a) Digital Inputs: Energize each digital input (smoke detector, end switch, control relay, flow switch, differential pressure switch, or other components)



- in the field. Verify at panel.
- b) Digital Outputs: Force on each digital output (solenoid valve, motor starter, control relay, or other components) at control panel. Field verify corresponding final element for proper stroke/status.
 - c) Analog Inputs: Compare field reading of each analog input (transmitters, thermistor, or other components) with that displayed on graphic screens, and auxiliary panels.
 - d) Analog Outputs: Force each analog output (I/P) to values of 0 percent, 25 percent, 50 percent, 75 percent and 100 percent. Field verify corresponding final element (valve or damper) positions from fully closed to open, based upon stated range.
3. Calibration of Test Instruments: Use calibrated test instruments for all point checks as specified herein. The calibration of the test instruments shall be traceable to the National Institute of Standards And Technology (NIST) standards. A static system checkout shall be performed on a BAS instrument if the date of the test instrument calibration is within one year of the date of the check. Recalibrate test instruments annually and submit the NIST traceable instrument reports along with the static system checkout sheets.
- E. Control System Dynamic Check
1. Operational dynamic check shall include verification that control system, including sensors and actuators, performed as specified while interconnected to the process.
 2. Verify proper system communication with controllers and the ability to reset setpoints remotely from operator workstations.
 3. Verify the operation of each air handling unit, equipment system, steam system and hydronic systems in automatic.
 4. Verify and demonstrate that operator workstation interface graphic screens are displayed consistent with the drawings. Verify the status of each digital and analog value on every graphic screen is consistent with actual field device reading. Use only graphic screens accepted by the A/E and owner.
 5. Test each control loop to verify that it indicates proper percent of scale and correct scaling of engineering units.
 6. Verify stability of all control loops. Record and provide graphical trends for each control loop to verify loop stability is within specified limits.
 7. Test system failures, start-up sequences for air handling units, exhaust fans, heat recovery units, and hydronic systems. Verify warnings and fail to start logic.
 8. Submit Dynamic Performance Test Sheets indicating operating conditions after detailed dynamic checkout of the systems. The dynamic performance test sheets shall be in a tabular format and represent the contractor's sequence of operations and the tests described above. The person performing verification shall initial and date each verification test form adjacent to the test. Once the sequences and tests listed above are passed successfully, the test sheets shall be submitted for record.
- F. Alarms
1. The BAS Contractor will coordinate all alarming parameters with the Owner, or Owner's representative, prior to implementation of the database on the Central System Server (CSS).



2. For each project, each alarm and events shall be classified per the Owner's instruction for the proper category: Emergency, Life Safety, Security, Supervisory, Trouble, High, Medium, and Low.
3. Test each alarm identified in the contract documents. Verify that the control system displays proper indication. Test and verify proper acknowledgement of alarms from operator workstation.

1.09 DEMONSTRATION

- A. Demonstration of a completely commissioned system shall be a requirement for final completion.
- B. Demonstrate the operation of the hardware, software, and all related components and systems to the satisfaction of the Commissioning Authority and Owner. Schedule the demonstration with the Owner's representative 1 week in advance. Demonstration shall not be scheduled until all hardware and software submittals, and the Start-Up Test Report are approved. If the Work fails to be demonstrated to conform to Contract specifications, so as to require scheduling of additional site visits by the Commissioning Authority and Owner for re-demonstration, Contractor shall reimburse Owner for costs of subsequent Commissioning Authority site visits.
- C. The Contractor shall supply all personnel and equipment for the demonstration, including, but not limited to, instruments, ladders, etc. Contractor-supplied personnel must be competent with and knowledgeable of all project-specific hardware, software, and the HVAC systems. All training documentation and submittals shall be at the job site.
- D. Demonstration shall typically involve small representative samples of systems/equipment randomly selected by the Owner and CA.
- E. The system shall be demonstrated following the same procedures used in the Start-Up Test by using the approved Commissioning Checklists. Demonstration shall include, but not necessarily be limited to, the following:
 1. Demonstrate that required software is installed on each workstation. Demonstrate that graphic screens, alarms, trends, and reports are installed as submitted and approved.
 2. Demonstrate that points specified and shown can be interrogated and/or commanded (as applicable) from all workstations, as specified.
 3. Demonstrate that remote communication abilities are in accordance with these Specifications.
 4. Demonstrate correct calibration of input/output devices using the same methods specified for the Start-Up Tests. A maximum of 10 percent of I/O points shall be selected at random by the Commissioning Authority and/or Owner for demonstration. Upon failure of any device to meet the specified end-to-end accuracy, an additional 10 percent of I/O points shall be selected at random by Commissioning Authority for demonstration. This process shall be repeated until 100 percent of randomly selected I/O points have been demonstrated to meet specified end-to-end accuracy.
 5. Demonstrate that all DDC and other software programs exist at respective field panels. The Direct Digital Control (DDC) programming and point database shall be as submitted and approved.
 6. Demonstrate that all DDC programs accomplish the specified sequences of



operation.

7. Demonstrate that the panels automatically recover from power failures, as specified.
 8. Demonstrate that the stand-alone operation of panels meets the requirements of these guidelines. Demonstrate that the panels' response to LAN communication failures meets the requirements of these guidelines.
 9. Identify access to equipment selected by the Commissioning Authority and by the Owner. Demonstrate that access is sufficient to perform required maintenance.
 10. Demonstrate that required trend graphs and trend logs are set up per the requirements.
 11. Test each control loop display to verify that it indicates proper percent of scale and correct scaling of engineering units.
 12. Alarms: Test each alarm identified in Contract Documents. Verify that control system displays proper indication. Test and verify proper acknowledgement of alarms from supervisory station.
 13. For each system, demonstrate:
 - a) Cold start.
 - b) Sequence of operation.
 - c) Seasonal control as applicable.
- F. The demonstration shall be completed and approved prior to Substantial Completion.
- G. Any tests successfully completed during the demonstration will be recorded as passed for the functional performance testing and will not have to be retested.
- H. After completed system balancing, verify all space control operation including temperature, humidity and flow/static pressure recovery operation.
- I. Provide complete demonstration of equipment or systems requiring seasonal operation, during operating season. Perform multiple demonstrations as required within six months.
- J. Indicate type and cause of failures, as well as required remedial actions, on test report. Start-up and testing will be witnessed and verified by A/E, Owner, and/or commissioning agent. Requested tests, not outlined herein, will be evaluated for feasibility and impact on schedule and cost.
- K. Systems will not be accepted by Owner and A/E without approval of tests and required remedial action.
- L. Provide signed verification reports to the Owner for each system tested.
- M. Provide system demonstration and instructions.

1.10 TREND LOGS

- A. The Contractor shall configure and analyze all trends required under all specification sections. The BAS Contractor shall demonstrate functional trends two weeks prior to Functional Performance Testing.
- B. Record and print graphical trends for each control loop to verify loop stability is within specified performance limits. Each trend shall be for a duration of no less than 12 hours.



1. PARAMETER MAXIMUM ACCEPTABLE DEVIATION FROM SETPOINT

- | | |
|----------------------------|-----------------------------|
| a) Duct Static Pressure | Plus or minus 0.05 In. W.C. |
| b) Space Temperature | Plus or minus 2 degrees F |
| c) Air Flow | Plus or minus 5% |
| d) Duct Relative Humidity | Plus or minus 5% |
| e) Space Relative Humidity | Plus or minus 5% |

1.11 WARRANTY PERIOD:

- A. Warranty Period shall not commence until successful completion of the Demonstration.
- B. Trending: Throughout the Warranty Period, trend logs shall be maintained. Contractor shall forward archive trend logs to the Commissioning Authority/Owner for review upon Commissioning Authority/ Owner request. Commissioning Authority/ Owner will review these and notify contractor of any warranty work required.
- C. Opposite Season Testing: Within 6 months of completion of the Acceptance Phase, Commissioning Authority/ Owner shall schedule and conduct Opposite Season functional performance testing. Contractor shall participate in this testing and remedy any deficiencies identified
- D. End of Warranty Visit: Commissioning Authority/ Owner will conduct an End of Warranty walkthrough prior to the end of the Warranty Period. Contractor shall participate in this walkthrough and remedy any deficiencies identified.

1.12 SOFTWARE OPTIMIZATION ASSISTANCE

- A. The Contractor shall provide the services of a Technician as specified above at the project site to be at the disposal of the Commissioning Authority/Owner. The purpose of this requirement is to make changes, enhancements and additions to control unit and/or workstation software that have been identified by the Commissioning Authority/Owner during the construction and commissioning of the project and that are beyond the specified Contract requirements. The cost for this service shall be included with the bid. Requests for assistance shall be for contiguous or non-contiguous 4-hour sessions, unless otherwise mutually agreed upon by Contractor, Commissioning Authority, and Owner. The Owner's representative shall notify contractor 2 days in advance of each day of requested assistance.
- B. The Technician provided shall be thoroughly trained in the programming and operation of the controller and workstation software. If the Technician provided cannot perform every software task requested by the Commissioning Authority/Owner in a timely fashion, contractor shall provide additional qualified personnel at the project site as requested by the Commissioning Authority/Owner, to meet the total specified requirement [per building] on-site.

1.13 OPERATOR TRAINING

- A. Documented Owner's training shall be a requirement for final completion.
- B. On-Site Training: Provide services of BAS Contractor's qualified technical personnel for two 4-hour days to instruct Owner's personnel in operation and maintenance of



BAS. Provide services of Contractor's qualified technical

personnel for one 8-hour day to instruct the Owner's personnel in the operation and maintenance of Integrated Installer Control Sub-Systems, i.e. Chiller, Boiler, etc. Instruction shall be in a classroom setting at the project site for appropriate portions of the training. Training may be in non-contiguous days at the request of the Owner. The Owner's representative shall notify the contractor 1 week in advance of each day of requested training. The Contractor's designated training personnel shall meet with the Owner's representative for the purpose of discussing and fine-tuning the training agenda prior to the first training session. Training agenda shall generally be as follows:

1. Basic Operator Workstation (OWS) or Control Panel Interface Training – For all potential users of the OWS or Display:
 - a) Brief walk-through of building, including identification of all controlled equipment and condensed demonstration of portable controller and built-in operator interface device display capabilities
 - b) Brief overview of the various parts of the O&M Manuals, including hardware and software programming and operating publications, catalog data, controls installation drawings, and DDC programming documentation
 - c) Demonstration of login/logout procedures, password setup, and exception reporting
 - d) Demonstration of menu penetration and broad overview of the various features
 - e) Overview of systems installed.
 - f) Present all site-specific point naming conventions and points lists, open protocol information, configuration databases, back-up sequences, upload/download procedures, and other information as necessary to maintain the integrity of the system.
 - g) Overview of alarm features.
 - h) Overview of trend features.
 - i) Overview of reports and reporting
2. Hardware Training – For Maintenance and Control Technicians
 - a) Review of installed components and how to install/replace, maintain, commission, and diagnose them
3. Technician Training
 - a) Introduction to controller programming and overview of the programming application interface
 - b) General review of sequence of operation and control logic for the project site, including standalone and fail-safe modes of operation
 - c) Uploading/Downloading and backing up programs.
 - d) Network administration
 - e) Review of setpoint optimization and fine-tuning concepts

End of Section



SECTION 25 11 13 INTEGRATED AUTOMATION NETWORK SERVERS

GENERAL

1.02 SECTION INCLUDES:

- Operator Workstations (OWS)
- Control System Servers (CSS)
- Portable Operator Terminal (POT)

1.03 DESCRIPTION OF WORK:

Furnish and install software for Operator Interfaces and Control System Servers as required for the BAS functions specified. The manufacturer shall support all installed software for a period of two years after Substantial Completion at no additional cost to the Owner.

PRODUCTS

2.01 CONTROL SYSTEM SERVER (CSS)

The CSS is a virtual machine provided by American University. Coordinate all software requirements with the AU BAS/OIT Department to ensure compatibility with the virtual machine operating system and resources.

PART 3 EXECUTION

3.01 INSTALLATION

Install all software on the provided computers and verify that the systems are fully operational. Ensure licensing is provided for all software.

No components required for the legal use of the computer shall be withheld from the Owner.

All information required to install, configure, operate, diagnose, and maintain the system shall not be withheld from the Owner.

Install systems and materials in accordance with manufacturer's instructions.

END OF SECTION



SECTION 25 11 16 NETWORK ROUTERS, BRIDGES, SWITCHES AND HUBS

GENERAL

1.01 SECTION INCLUDES:

- A. Network Connections
- B. Local Supervisory LAN Gateways/Routers
- C. Communication Wiring, Raceways, Cabling
- D. Integrated Installer Provided Control Sub-Systems

1.02 DESCRIPTION OF WORK:

- A. BAS Contractor shall provide all interface devices and software to provide an integrated system connecting BCs, AACs, ASCs and Gateways to the Owner's LAN.

PRODUCTS

2.01 NETWORK CONNECTIONS

- A. Owner's WAN: American University will provide an internetwork connecting the BAS across multiple structures with a CSS. The BAS Contractor is not required to configure any components of this WAN. The final BAS internetwork shall use this WAN as the Primary LAN.
- B. All new sub networks must be BACnet/IP or BACnet/MSTP. No new work may implement an FLN network.
- C. All projects that require BBMD management must use a dedicated hardware BBMD management device. No software BBMD management within a controller will be allowed.
- D. BAS connections to third-party BACnet objects must implement a virtual point bound to the object and not hard coded in the BAS software. Third-party BACnet object connections must be configured to allow for the fastest refresh rate available from the third-party vendor not to exceed 3 seconds at the BAS interface. Third-party BACnet object connections must maintain a continuous reliable connection to the BAS. The BAS contractor is responsible for adding hardware/software as necessary to accomplish this connectivity requirement.

If the BAS contractor determines they are not able to communicate with the vendors BACnet object to meet performance requirements defined in Division 25 an alternative communications method may be requested. The BAS contractor must request an alternative communication method via RFI to the Design Team and AU BAS Department.

2.02 LOCAL SUPERVISORY LAN GATEWAYS/ROUTERS

- A. The Supervisory Gateway shall be a BC that acts as a gateway/router



- between the Supervisory LAN CSSs and the Primary LAN.
- B. The gateway shall perform information translation between the Primary LAN and the Local Supervisory LAN, which is Ethernet TCP/IP and shall preferably use BACnet over IP.
 - C. The gateway shall contain its own microprocessor, RAM, battery, real-time clock, communication ports, and power supply as specified for a BC in Section 25 55 00. Each gateway/router shall be mounted in a lockable enclosure.
 - D. The gateway/router shall allow centralized overall system supervision, operator interface, management report generation, alarm annunciation, acquisition of trend data, and communication with control units. It shall allow system operators to perform the following functions from the CSS, OWSs, and POTs:
 - 1. Configure systems.
 - 2. Monitor and supervise control of all points.
 - 3. Change control setpoints.
 - 4. Override input values.
 - 5. Override output values
 - 6. Enter programmed start/stop time schedules.
 - 7. View and acknowledge alarms and messages.
 - 8. Receive, store and display trend logs and management reports.
 - 9. Upload/Download programs, databases, etc. as specified.
 - E. Upon loss of power to the Gateway, the battery shall provide for minimum 100-hour backup of all programs and data in RAM. The battery shall be sealed and self-charging.
 - F. The Gateway shall be transparent to control functions and shall not be required to control information routing on the Primary LAN.

2.03 COMMUNICATION WIRING, CABLING AND RACEWAYS

- A. Wiring and Raceways
 - 1. General: Provide copper conductors, plenum cable, and raceways as specified in the applicable sections of Division 26, and 25 5500. Where the documents conflict request clarification from the Owner.
 - 2. Insulated wire shall use copper conductors and shall be UL listed for 90°C (200°F) minimum service.
- B. Fiber Optic Cable
 - 1. Optical cable: Optical cables shall be duplex 900 mm tight-buffer construction designed for intra-building environments. Sheath shall be UL listed OFNP in accordance with NEC Article 770. Optical fiber shall meet the requirements of FDDI, ANSI X3T9.5 PMD for 62.5/125mm.
 - 2. Connectors: Terminate optical fibers with ST type connectors. Connectors shall have ceramic ferrules and metal bayonet latching bodies.



2.04 INTEGRATED INSTALLER PROVIDED CONTROL SUB-SYSTEMS

- A. The Gateway defined in Article 2.03 shall perform information translation between the Primary LAN or the Local Supervisory LAN, which is 100 Mbps Ethernet TCP/IP, and the Installer Provided Control Sub-System.
- B. The Gateway and the Installer Provided Control Sub-System shall use the agreed upon communication protocol required to connect the control sub-system to the BAS. This protocol shall be agreed upon and as defined in Section 25 5500.
- C. The Gateway and the Installer Provided Control Sub-System shall support full bi-directional communication translation as defined by the applicable protocol implementation specification as defined in Section 25 5500.
- D. The Installer Provided Control Sub-System shall provide all objects, points, variables and any other configuration parameters defined by its protocol implementation conformance specification without any added network protocol translation devices other than the BAS BC and its own control sub-system components. The following points shall be provided at a minimum:
Edit the following list(s) as necessary to meet the project needs of the University based on equipment size and application.
 1. The following Chilled Water System points shall be mapped as a minimum:
 - a) CHW Supply and Return Temperatures
 - b) CW Supply and Return Temperatures
 - c) Power Consumption (kW)
 - d) Percent of Power Consumption (compared to maximum)
 - e) Bearing Temperature
 - f) Suction and Head Pressures
 - g) Suction and Head Temperatures
 - h) All available alarms; common alarm as minimum
 - i) Chiller Status
 - j) Enable/Disable
 - k) Current Limit Percent
 - l) CHW Setpoint and Setpoint Reset
 2. The following Hot Water System points shall be mapped as a minimum:
 - a) Boiler Supply Temperatures
 - b) Boiler Pressure
 - c) Call for Heat
 - d) Boiler Ignition On
 - e) All available alarms; common alarm as minimum
 - f) Boiler Status
 - g) Firing Rate
 - h) Enable/Disable



- i) HW Setpoint and Setpoint Reset
3. The following Variable Frequency Drive points shall be mapped at a minimum:
 - a) Output Frequency
 - b) Motor Speed (RPM, %, or Engineering units)
 - c) Motor Current
 - d) Calculated Motor Torque
 - e) Calculated Motor Power (kW)
 - f) DC Bus Voltage
 - g) Output Voltage
 - h) kWh meter (resettable)
 - i) mWh meter
4. The following Computer Room Air Conditioner points shall be mapped as a minimum:
 - a) Space Temperature and Humidity
 - b) Change Filter
 - c) Humidifier Status
 - d) Unit Off Local / Off Remote
 - e) All available alarms; common alarm as minimum
 - f) Unit Status
 - g) Enable/Disable
 - h) Space Temperature and Humidity Setpoints.
5. All Lucid Meter Management points shall be mapped:
 - a) This requirement applies to projects with Nexus, Flexim, or Shark utilities meters monitored by Lucid Meter Management software.
 - b) Provide an interface to the management software and/or meter to collect utility for use by the BAS.
 - c) BAS connection to the utility meter must not interfere with the meter's operation or calibration.
 - d) BAS connection to the management software must not interfere with the software meter connection or data collection process.
 - e) Coordinate utility meter data management with AU before implementation.

EXECUTION

3.01 INSTALLATION OF CONTROL SYSTEMS:

- A. General: Install systems and materials in accordance with manufacturer's instructions, roughing-in drawings and details shown on drawings.
- B. BAS Contractor shall provide leadership as the Integration Coordinator for all Installer Provided Control Sub-Systems. Contractor to coordinate work



progress, see Section 25 55 00 for details.

- C. BAS Contractor shall coordinate and supervise all interface devices and software to provide an integrated system.
- D. BAS Contractor shall confirm all third party vendor connections meet Division 25 performance requirements. Provide a report to the Design Team and AU BAS Department for any connections that fail to pass performance requirements. This includes all BACnet/IP, BACnet/Ethernet, BACnet/MSTP, MODBUS and similar approved connections.
- E. BAS Contractor shall closely coordinate with the A/E to locate all required Ethernet ports and request IP address assignments from the Owner's IT department. The BAS Project Manager shall provide the required activation date for Ethernet ports and addresses at least 30 days in advance.
- F. The BAS network shall be connected to the permanent BAS Server prior to the start of TAB to ensure all TAB data is retained on the permanent server and available for review by the CxA and A/E prior to final completion and turnover.
- G. Temporary BAS Internetwork: Should the final network connection not be available during the commissioning phase of the project; the BAS Contractor shall install a temporary internetwork for the BAS until such time that the WAN is available. This network can be of any type and configuration as it is temporary in nature. The only restriction is to provide some level of access control to the network.

END OF SECTION



SECTION 25 14 13 REMOTE CONTROL PANELS

GENERAL

1.01 SECTION INCLUDES:

- A. Building Controller (BC)
- B. Advance Application Specific Controller (AAC)
- C. Application Specific Controller (ASC)

1.02 DESCRIPTION OF WORK:

- A. Furnish and Install DDC Control units and/or Smart Devices required supporting specified building automation system functions.

PRODUCTS

2.01 GENERAL REQUIREMENTS

- A. Provide Building Controllers (BC), Advanced Application Controllers (AAC), Application Specific Controllers (ASC), Smart Actuators (SA), and Smart Sensors (SS) as required to achieve performance specified in Sections 25 55 00. Every device that integrates with the BAS must conform to a standard BACnet Device profile as specified in ASHRAE 135. BACnet Secure Connect (BACnet/SC) must be applied for all BACnet/SC capable controllers.
- B. All controller hardware shall be suitable for anticipated ambient conditions. Controllers used outdoors or in wet ambient conditions shall be mounted in NEMA rated waterproof enclosures and shall be rated for operation at -20°F to 140°F. Controllers used in conditioned spaces shall be mounted in dust-protective enclosures and shall be rated for operation at 32°F to 120°F.
- C. Shorting an input or output point to itself, to another point, or to ground shall cause no controller damage. Input or output point contact with up to 24 V for any duration shall cause no controller damage.

2.02 STAND-ALONE FUNCTIONALITY

- A. General: These requirements clarify the requirement for stand-alone functionality relative to packaging I/O devices with a controller. Stand-alone functionality is specified with the controller and for each Application Category specified in Part 3. The BAS Contractor shall comply with Section 25 55 00 to select the appropriate controllers.
- B. Functional Boundary: Provide controllers so that all points associated with and common to one unit or complete system/equipment shall reside within a single control unit. The boundaries of a standalone system shall be as dictated in the contract documents. Generally, systems specified for the Application Category will dictate the boundary of the standalone control functionality.
- C. The following configurations are considered unacceptable with reference to a controller's standalone functionality:



1. Multiple controllers enclosed in the same control panel to accomplish the point requirement.
- D. In normal operation, components comprising the BAS system shall communicate over its own independent Ethernet LAN. However, control panels and controllers shall function independently in stand-alone mode, in the event of any network or server failure.
- E. BAS Local Area Network Level (LAN): The communication extension shall support a series of controllers and shall communicate bi-directionally with the peer-to-peer network for transmission of global data.

2.03 BUILDING CONTROLLER (BC)

- A. General Requirements:
 1. The BC(s) shall provide fully distributed control independent of the operational status of the CSS. All necessary calculations required to achieve control shall be executed within the BC independent of any other device. All control strategies performed by the BC(s) shall be both operator definable and modifiable through the Operator Interfaces.
 2. BCs shall perform overall system coordination, accept control programs, perform automated system functions, control peripheral devices and perform all necessary mathematical and logical functions. BCs shall share information with the entire network of BCs and AACs/ASCs for full global control. BC shall contain sufficient memory for all specified global control strategies, user defined reports and trending, communication programs, and central alarming.
 3. BCs shall be connected to a network that qualifies as a Primary Controller LAN.
 4. A communication port for operator interface through a terminal shall be provided in each BC. It shall be possible to perform all program and database back up, system monitoring, control functions, and BC diagnostics through this port.
 5. BC Power Loss:
 - a) Upon a loss of power to any BC, the other units on the primary controlling network shall not in any way be affected.
 6. BCs may include LAN communications interface functions for controlling secondary controlling LANs.
 7. BCs shall be mounted in packaged equipment enclosures or in locking wall-mounted enclosures.
 8. BC must be capable of performing primary integration to third party BACnet devices and in this case comply as a BACnet Building Controller (B-BC) device profile as specified in ANSI/ASHRAE Standard 135. Where possible, BACnet Secure Connect (BACnet/SC) should be applied for secure BAS communications.



9. Trend data shall be stored at the BC and uploaded to the supervisory station when retrieval is desired and scheduled. Uploads shall occur based upon either user-defined interval, manual command or when the trend buffers are full. All trend data shall be available for use in 3rd party personal computer software.

2.04 ADVANCED APPLICATION SPECIFIC CONTROLLER (AAC) AND APPLICATION SPECIFIC CONTROLLER (ASC)

A. General Requirements:

1. AACs and ASCs shall provide intelligent, standalone control of systems and equipment. It shall be able to share information with every other BC and AAC /ASC on the entire network.
2. All point data, algorithms and application software within an AAC /ASC shall be modifiable from the Operator Workstation. Non-customizable algorithms are not acceptable.

B. Air Terminal Unit Controllers:

1. Terminal box controllers used in HVAC applications controlling damper positions to maintain a quantity of supply or exhaust air serving a space shall have an automatically initiated function that resets the volume regulator damper to the fully closed position on a scheduled basis. The controllers shall initially be set up to perform this function once every 24 hours. The purpose of this required function is to reset and synchronize the actual damper position with the calculated damper position and to assure the damper will completely close when commanded. The software shall select scheduled boxes randomly and shall not allow more than 5% of the total quantity of controllers in a building to perform this function at the same time. When possible, the controllers shall perform this function when the supply or exhaust air system is not operating or is unoccupied.

EXECUTION

3.01 INSPECTION:

- A. Examine areas and conditions under which control systems are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to the BAS Contractor.

3.02 INSTALLATION OF CONTROL SYSTEMS:

- A. General: Install systems and materials in accordance with manufacturer's instructions, specifications roughing-in drawings and details shown on drawings. BAS Contractor shall install all controllers in accordance with the manufacturer's installation procedures and practices.
- B. Mount BC and CUs adjacent to associated equipment on vibration free walls or freestanding angle iron supports. Do not mount on AHU housing. Provide nameplates for instruments and controls inside and identify associated system on face of cabinet. Provide mechanically fastened cabinet



nameplates, using nomenclature matching that used for devices in the approved Div. 25 submittal.

3.03 HARDWARE APPLICATION REQUIREMENTS

- A. General: The functional intent of this specification is to allow cost effective application of the control system while maintaining the integrity and reliability of the control functions. The specific requirements indicated below are required for the respective application.
- B. Standalone Capability: Each Control Unit (CU) shall be capable of performing the required sequence of operation for the associated equipment. All physical point data and calculated values required to accomplish the sequence of operation shall originate within the associated CU.
- C. Mounting:
 - a) Refer to Section 25 55 00 for details of mounting enclosures.
 - b) CUs that control equipment located above accessible ceilings shall be mounted on the equipment in an accessible enclosure (36" clearance required) and shall be rated for plenum use.
 - c) CUs that control equipment mounted in a mechanical room may either be mounted in, on the equipment, or on the wall of the mechanical room at an adjacent, accessible location.
 - d) CUs that control equipment mounted outside the building envelope or in occupied spaces shall either be located inside the unit or in a proximate mechanical space.
- D. Programmability: Operator shall be able to modify all setpoints (temperature and airflow), scheduling parameters associated with the unit, tuning and set up parameters, inter-stage timing parameters, and mode settings. Application-specific block control algorithms may be used application specific controllers (ASC) to meet the sequence of operations. The control algorithm must be customizable for advanced application controllers (AAC) and building controllers (BC).
- E. Where associated control functions involve functions from different categories identified below, the requirements for the most restrictive category shall be met.
 - 1. Application Category 0 (Distributed monitoring):
 - a) Applications in this category include the following:
 - b) Monitoring of variables that are not used in a control loop, sequence logic, or safety
 - i. Points on BCs, AACs, and ASCs may be used in these applications as well as SDs and/or general-purpose I/O modules.
 - ii. Where these points are trended, BAS Contractor shall verify and document that the network bandwidth is acceptable for such trends and is still capable of acceptable and timely control function.
 - 2. Application Category 1 (Application Specific Controller):



- a) Applications in this category typically include the following terminal equipment controllers:
 - i. Fan Coil Units
 - ii. Airflow Control Boxes (VAV and Constant Volume Terminal Units)
 - iii. Misc. Heating Units
 - iv. Single Zone; Unitary equipment less than 15- ton Package Terminal AC Units, Package Terminal Heat Pumps, Split-System AC Units, Split-System Heat Pumps, Water-Source Heat Pumps
 - v. Variable Speed Drive (VSD) controllers not requiring safety shutdowns of the controlled device.
 - b) Network Restrictions: Limit the number of nodes on the network to 80% of the maximum recommended by the manufacturer.
3. Application Category 2 (General Purpose Terminal Controller)
- a) Applications in this category include the following:
 - i. Unitary Equipment greater than or equal to 15- ton Air Conditioners, Heat Pumps, Packaged Heating/Cooling Units etc.
 - ii. Small, Constant Volume Single Zone Air Handling Units
 - iii. Constant Volume Pump Start/Stop
 - iv. Misc. Equipment Start/Stop
 - v. Misc. Monitoring not directly associated with a control sequence and where trending is not critical
 - b) All outputs must have manual override capability.
 - c) BCs may be used in these applications.
 - d) ASC's may be used in these applications provided the ASC meets all requirements specified below. This category requires a general-purpose ASC to which application-specific control algorithms can be attached.
 - e) Standalone Capability: Only the following data (as applicable) may be acquired from other CUs via LANs. In the event of a loss of communications with any other CUs, or any fault in any system hardware that interrupts the acquisition of any of these values, the CU shall use the last value obtained before the fault occurred. All points configured for trending shall continue to store data at the local module.
 - f) Network Restrictions: Limit the number of nodes servicing any one of these applications on the AAC/ASC LAN to 80% of the manufacturer's recommended maximum.
4. Application Category 3 (Advanced Application Controller)
- a) Applications in this category include the following:
 - i. Unitary Equipment greater than or equal to 15- ton Air Conditioners, Heat Pumps, Packaged Heating/Cooling Units etc.
 - ii. Large Constant Volume Air Handlers
 - iii. VAV Air Handlers {generally >5,000 and <10,000cfm}



- iv. Dual Duct Air Handlers {generally >5000 and <10,000 cfm}
 - v. Multi-Zone Air Handlers
 - vi. Self-Contained VAV Units
 - b) All outputs must have manual override capability.
 - c) BCs may be used in these applications.
 - d) AAC's may be used in these applications provided the AAC's meets all requirements specified below:
 - i. All control functions and physical I/O associated with a given unit reside in one AAC.
 - e) Standalone Capability: Only the following data (as applicable) may be acquired from other CUs via LANs. In the event of a loss of communications with any other CUs, or any fault in any system hardware that interrupts the acquisition of any of these values, the CU shall use the last value obtained before the fault occurred. All points configured for trending shall continue to store data at the local module.
 - f) Network Restrictions: Each LAN which participates in the transfer of data between the CU and the local operator workstation shall be subject to the following criteria:
 - i. The building controller LAN shall be subject only to the manufacturer's published LAN limitations.
5. Application Category 4
- a) Applications in this category include the following:
 - i. Central Cooling Plant
 - ii. Central Heating Plant
 - iii. Cooling Towers
 - iv. Sequenced or Variable Speed Pump Control
 - v. Local Chiller Control (unit specific)
 - vi. Local Free Cooling Heat Exchanger Control
 - vii. Air Handlers over 10,000 cfm or serving critical areas
 - viii. Variable Speed Drive (VSD) controllers for air handlers, exhaust systems and variable volume pumping
 - b) All outputs must have manual override capability.
 - c) BCs shall be used in these applications.

3.04 CONTROL UNIT REQUIREMENTS

- A. Refer to Section 25 55 00 for requirements pertaining to control unit quantity and location.

3.05 CONTROL MODULE INSTALLATION

- A. Building Controller (BC):
 - 1. The BAS Contractor shall follow the specifications shown in the manufacturer's hardware installation guide unless stated otherwise.



2. Refer to Section 25 5500 for power supply requirements. Power shall enter the control panel at an internal junction box that includes a standard receptacle and switch for panel power.
- B. Field Bus Controllers (AAC/ASC):
1. The BAS Contractor shall follow the specifications shown in the manufacturer's hardware installation guide unless stated otherwise herein.
 2. Controller Power shall have a separate disconnect (or fuse) for each controller.
- C. Expansion Modules:
1. The BAS Contractor shall follow the specifications shown in the manufacturer's hardware installation guide unless stated otherwise herein.

END OF SECTION



SECTION 25 15 16 SOFTWARE FOR CONTROL AND MONITORING NETWORKS

GENERAL

1.01 SECTION INCLUDES:

- A. System Software
- B. Programming Description
- C. Control Algorithms
- D. Energy Management Applications
- E. Password Protection
- F. Alarm Reporting
- G. Trending
- H. Data Acquisition and Storage
- I. Dynamic Color Graphics

1.02 LICENSING

- A. All software used for the operator interface, programming environment, networking, database management and any other software used by the BAS Contractor to install the system or needed to operate the system to its full capabilities shall be licensed and provided.
- B. Include all required third-party software licenses.
- C. Provide copies/backup of licensing and original software.

PRODUCTS

2.01 GENERAL SOFTWARE REQUIREMENTS

- A. **Functionality and Completeness:** The BAS Contractor shall furnish and install all software and programming necessary to provide a complete and functioning system as specified. The BAS Contractor shall include all software and programming not specifically itemized in these Specifications, which is necessary to implement, maintain, operate, and diagnose the system in compliance with these Specifications.
- B. **Software Rights:** No aspect of the control programming that executes the sequence of operations shall be considered proprietary. The University and its representatives shall have full and unlimited access to all programming manuals, site specific programming at all levels, updates to all manuals, etc. Advanced programming training is specified. Properly trained individuals will be given applicable password access to view and modify control programming without consent or notification of the contractor. Any system in which control sequence programming is considered proprietary in any way will not be considered.
- C. All application software shall be user programmable based upon user access control privileges.



- D. Custom Software: Contractor shall be required to retain backup copies of custom software drivers and documentation of same for no less than ten years with free access to AU for the same period. If the backup is not available within the specified time frame, Contractor shall recreate the custom software at no charge to AU.

2.02 ALARM AND EVENT MANAGEMENT REPORTING

- A. The BAS Contractor will implement Alarming for all alarm configurable points.
- B. Alarm management shall be provided to monitor and direct alarms to operator devices. All alarms and events shall be routable to all Operator Workstations.
 - 1. Alarm Descriptor: Each alarm or point change shall include that point's English language description, the time and date of occurrence. The user shall be able to display and archive all alarm information for future reference.
 - 2. Alarm Prioritization: The software shall allow users to define the handling and routing of each alarm by their assignment to discrete priority levels. Users shall have the ability to manually inhibit alarm reporting for each individual alarm and for each priority level. Contractor shall coordinate with the Owner to establish alarm priority definitions.
 - a) Life Safety – any life safety event (i.e. smoke detector)
 - b) Emergency – major system failure or damage possible (i.e. controller failure)
 - c) High – environmental sensors (i.e. out-of-range temperature)
 - d) Medium - energy waste (i.e. fighting valves)
 - e) Low- maintenance message (i.e. runtime monitor, filter status)
 - f) Supervisory - control events (i.e. Totalization Resets, Scheduled Events Occurrence, etc.)
 - 3. Alarm Report Routing: All alarms associated with a given priority level shall be routed to all operator devices associated with that priority level. A default operator device shall be configured to receive all alarms regardless of priority level.
 - 4. Alarm Acknowledgment: For alarm priority levels that are directed to a workstation screen, an indication of alarm receipt shall be displayed immediately, and shall remain on the screen until acknowledged by a user having a password that allows alarm acknowledgment. Upon acknowledgment, the complete alarm message string (including date, time, and username of acknowledging operator) shall be archived.
- C. It shall be possible for any operator to receive a summary of all alarms, regardless of acknowledgement status.



2.03 TRENDING

- A. The software shall be able to display historical data in both a tabular and graphical format. The requirements of this trending shall include the following:
 - 1. Install historical trends for all physical (AI, AO) analog points, all physical digital points (DI, DO) and all virtual points used in any loop control algorithm. Unless directed otherwise from the Owner use a ten-minute interval for analog values and change of value for digital values.
 - 2. The trended value range shall be selectable by the operator.
 - 3. The data points must be exportable from any operator interface in comma-separated values (CSV) or MS Excel format.

2.04 TOTALIZATION

- A. The software shall support totalizing analog, digital, and pulsed inputs and be capable of accumulating, storing, and converting these totals to engineering units used in the documents. These values shall generally be accessible to the Operator to support management-reporting functions.
- B. Totalization of electricity use/demand (hourly, daily & monthly) shall allow application of totals to different utility tariff rate periods, which shall be user definable.
- C. When specified to provide electrical or utility Use/Demand, the BAS Contractor shall obtain from the local utility all information required to obtain meter data, including k factors, conversion constants, and the like.
- D. Provide detailed energy consumption reports for all facility utilities stored as their final calculated value on a daily, monthly, and yearly basis. The archive of this data shall be for no less than one year.

2.05 SCHEDULING

- A. All schedules must use BACnet objects with read/write capability enabled. The schedule must allow monitoring and manipulation of the schedule through external BACnet software. No hard coded or proprietary schedule routines are allowed.
- B. Provide a graphic utility for user-friendly operator interface to adjust equipment-operating schedules.
- C. Scheduling feature shall include multiple day occupancy schedules, holiday schedules and override schedules, each with start time and stop time. Schedules shall be individually editable for each day and holiday.
- D. Scheduling feature shall allow for schedules to be applied to individual equipment units, floorplans, buildings and/or the campus.
- E. Schedules shall be hierarchical allowing all devices/systems below a given device/system to follow the same schedule.
- F. Timed override feature shall allow an operator to temporarily change the state of scheduled equipment. An override command shall be selectable to apply to an individual unit, all units assigned to a given master schedule, or



to all units in a building. Timed override shall terminate at the end of an operator selectable time, or at the end of the scheduled occupied/unoccupied period, whichever comes first.

- G. A yearly calendar feature shall allow assignment of holidays, and automatic reset of system real time clocks for transitions between daylight savings time and standard time.

2.06 OVERRIDES

- A. BAS shall provide an audit log report of all overrides currently active and historical overrides along with the user who initiated the override.
- B. Timed override feature shall allow an operator to temporarily change the state of scheduled equipment. An override command shall be selectable to apply to an individual unit, all units assigned to a given schedule, or to all units in a building. Timed override shall terminate at the end of an operator selectable time, or at the end of the scheduled occupied/unoccupied period, whichever comes first.

2.10 OBJECT STRUCTURING AND NAMING

- A. Object Definition: An object is any component in the BAS that requires naming using printable Standard English language characters in a format easily understood by the end user of the software. Examples of objects are:
 - 1. BAS Architecture Devices
 - 2. Zone and Event Definitions
 - 3. Schedule Definitions
 - 4. Report Definitions
 - 5. Dynamic Graphics and Graphic Background Drawings
 - 6. Programs
 - 7. Points
- B. Refer to the Object Naming Guide in Section 25 55 00.13.
- C. All object names shall adhere to the format as established in the Object Naming Guide. Objects shall include all physical I/O points, calculated points used for standard reports, and all application program parameters. For each BAS object, a specific and unique object name shall be required.
- D. General: Name objects consistently across all facilities. The BAS Contractor shall configure the systems from the perspective of the entire WAN and attached BAS networks, not solely the local project. The Object Naming Guide shall be implemented as much as practical, and any deviations from the guide shall be pre-approved by the Owner or Owner's representative. The BAS Contractor must obtain the latest Object Naming Guide documents prior to developing their object database.
 - 1. All tables defined below shall be provided in both hard copy and in electronic format (MS Excel and PDF).
 - 2. The BAS Contractor shall coordinate with Owner and compile and submit all proposed tables for review prior to any object programming



- or project startup.
 - 3. Project closeout documents shall include up-to-date and accurate completed versions of all tables. The BAS Contractor shall deliver to the Owner the final table versions prior to Substantial Completion of the system.
 - 4. See Section 25 55 00 for the general requirements for point control performance parameters.
- E. Point Name Summary Table
- 1. The term 'Point' is a generic description for the class of object represented by analog and binary inputs, outputs, and values.
 - 2. With each schematic, the BAS Contractor shall provide a Point Name Summary Table listing:
 - a) Building number and/or abbreviation
 - b) System Name
 - c) Device Name
 - d) Full point name (see Object Naming Guide)
 - e) Point description
 - f) Ethernet backbone network number,
 - g) Integration Network number
 - h) Integration Device ID
 - i) Integration Device MAC address
 - j) Integration Object ID (object type, instance number)
 - k) State Text
 - l) Change of Value Assigned
 - m) Engineering Units
 - 3. The Point Name Summary Table shall illustrate Network Variables and Data Link Bindings when necessary.
- F. BAS Architecture Device Name Summary Table
- 1. The term "Device" refers to an individual programmatic representation of a BAS controller in the facility.
 - 2. With each schematic the BAS Contractor shall provide a BAS Architecture Device Name Summary Table listing the names of all controllers that will be incorporated into the project.
 - 3. The table shall include the proposed location in the facility of the device.
 - 4. The table shall contain empty columns labeled as the following:
 - a) Host Name
 - b) DHCP Server Address
 - c) Default Gateway
 - d) Subnet Mask
 - e) IP Address



- G. Device Addressing Convention:
 - 1. All assignments of network numbers, TCP/IP addresses and Device Object IDs shall be coordinated with the Owner's network manager.
 - 2. The BAS Contractor shall coordinate with the Owner to ensure that no duplicate Device Object IDs or names occur.
 - 3. Alternative Device ID schemes shall be approved before project commencement by the Owner.
 - 4. Device object ID must be unique per the naming convention requirements within the BACnet internetwork.

2.11 OPERATOR INTERFACE GRAPHIC SOFTWARE

- A. Graphic software shall facilitate user-friendly interface to all aspects of the System Software specified above. Provide a graphic package that provides for intuitive operation of the systems without extensive training and experience. It shall facilitate logical and simple system interrogation, modification, configuration, and diagnosis. Context sensitive help shall be provided within the user interface via a 'help' function.
- B. The software shall allow for the user's creation of user-defined, color graphic displays of geographic maps, building plans, floor plans, and mechanical and electrical system schematics. These graphics shall be capable of displaying all point information from the database including any attributes associated with each point (i.e., engineering units, etc.). In addition, operators shall be able to command equipment or change setpoints from a graphic.
- C. Dynamic Data Displays: Dynamic physical point values shall automatically update without operator intervention. Point value fields shall be displayed with a color code depicting normal, abnormal, override and alarm conditions.
- D. Point Override Feature: Each displayed point shall be capable of individual enable/disable to allow override of digital points or changing of analog point values. The graphic point override feature shall be subject to password level protection. Points that are overridden shall be reported as an alarm, and shall be displayed in a coded color. The alarm message shall include the operator's username. A list of points that are currently in an override state shall be available through menu selection.
- E. Zone/Equipment Color: Floor plan graphics shall be color coded by the equipment served as follows; green = zone temperature within setpoint, blue/dark blue = zone temperature below setpoint, yellow/orange = zone temperature above setpoint, red = zone temperature/equipment in alarm range, white = equipment on normal, grey = equipment off normal.
- F. Graphics Development Package: Graphic development and generation software shall be provided to allow the user to add, modify, or delete system graphic displays.
 - 1. The BAS Contractor shall use the BAS vendor's Standard Graphical packages when creating graphic backgrounds.
 - 2. All Graphics created shall use a common background template with



which to base all custom graphical representations. The template shall contain the following attributes;

- a) Status Bar: A single bar across the bottom of every graphic containing hierarchical graphic links to other system graphics, general OA conditions and the current BAS system time.
 - b) Title Bar: A single bar across the top of every graphic containing the System Name the graphic represents. Additionally, where required the title bar shall contain the areas served by the System represented.
 - c) Mode Bar: A single bar just below the Title bar of equal dimensions to the Title bar. This bar is optional but must be included on all system graphics where the system contains programmatic modes of operation or distress modes. The Mode bar shall display the current operating mode and any other relevant information to mode operation.
3. The BAS Contractor shall provide libraries of pre-engineered screens and symbols depicting standard air handling unit components (e.g. fans, cooling coils, filters, dampers, etc.), mechanical system components (e.g., pumps, chillers, cooling towers, boilers, etc.), complete mechanical systems (e.g. constant volume-terminal reheat, VAV, etc.) and electrical symbols.
 4. The Graphic Development Package shall use touchscreen input, mouse, or similar pointing device to allow the user to perform the following:
 - a) Define symbols
 - b) Position items on graphic screens
 - c) Attach physical or virtual points to a graphic
 - d) Define background screens
 - e) Define connecting lines and curves
 - f) Locate, orient and size descriptive text
 - g) Define and display colors for all elements
 - h) Establish correlation between symbols or text and associated system points or other displays.
 - i) Create hot spots or link triggers to other graphic displays or other functions in the software.

EXECUTION

3.01 SYSTEM CONFIGURATION

- A. BAS Contractor shall thoroughly and completely configure BAS system software, supplemental software, network communications, CSS, OWS, portable operator's terminal, and remote communications.



3.02 SITE-SPECIFIC APPLICATION PROGRAMMING

- A. Provide all database creation and site-specific application control programming as required by the Specifications, national and local standards and for a fully functioning system. The BAS Contractor shall provide all initial site-specific application programming and thoroughly document programming. It is the BAS Contractor's responsibility to request clarification on sequence issues that are unclear or subject to interpretation.
- B. All site-specific programming shall be fully documented and submitted for review and approval, prior to downloading into the panel, at the completion of functional performance testing, and at the end of the warranty period.
- C. All programming, graphics and data files must be maintained in a logical system of directories with self-explanatory file names. All files developed for the project will be the property of AU and shall remain on the workstation(s)/server(s) at the completion of the project.

3.03 PASSWORD SETUP

- A. The BAS Contractor shall assist operators with assigning usernames, passwords, and password levels.

3.04 POINT PARAMETERS

- A. Provide the following minimum programming for each I/O point as applicable:
 - 1. Name
 - 2. Address
 - 3. Engineering units
 - 4. State Text, custom State Text where required.
 - 5. Offset calibration and scaling factor for engineering units
 - 6. Output Range
 - 7. Default value to be used when the actual measured value is not reporting. This is required only for points that are transferred across the primary and/or secondary controlling networks and used in control programs residing in control units other than the one in which the point resides. Events causing the default value to be used shall include failure of the control unit in which the point resides, or failure of any network over which the point value is transferred.

3.05 TREND DATA MANAGEMENT

- A. The BAS Contractor shall create, establish, and store trend logs for all trend capable hardware points, virtual points and calculated setpoints.
- B. The Owner or his representative will analyze trend logs of the system operating parameters to evaluate normal system functionality. The BAS Contractor shall establish these trends and ensure they are being stored properly on the CSS.
 - 1. Data shall include a single row of field headings and the data thereafter shall be contiguous. Each record shall include a date and time field or



single date stamp. Recorded parameters for a given piece of equipment or component shall be trended at the same intervals and be presented in a maximum of two separate 2-dimensional formats with time being the row heading and field name being the column heading.

- C. The BAS Contractor shall create standard graphical trends representing the setpoint and measured value for each system.
- D. The CSS shall be configured and/or upgraded as necessary to provide historical trend archiving for up to one year for all trend capable points on this project. Historical trend data older than one year shall be automatically purged to maintain database integrity and size.

3.06 ALARMS

- A. General: The BAS Contractor will be responsible for setting initial enhanced alarm parameters. No reporting actions will be initiated during construction unless directed by the Owner. See Section 25 5500 for the general requirements.
- B. Override Alarms: Any point that is overridden through the override feature of the graphic workstation software shall be reported as an alarm.
- C. Analog Input Alarms: For each analog input, program an alarm message for reporting whenever the analog value is outside of the programmed alarm limits. Report a 'Return-to-Normal' message after the analog value returns to the normal range, using a programmed alarm differential. Contractor shall coordinate with the Owner for final values based on the following parameters:
 - 1. Space temperature, except as otherwise stated in sequence of operation (all values adjustable):
 - a) Low alarm: 64°F
 - b) Low return-to-normal: 68°F
 - c) High alarm: 85°F
 - d) High return-to-normal: 80°F
 - 2. Controlled media temperature other than space temperature (e.g. AHU discharge air temperature, condenser water supply, chilled water supply, etc.). If controlled media temperature setpoint is reset, alarm setpoints shall be programmed to follow setpoint (all values adjustable):
 - a) Low alarm: 3°F below setpoint
 - b) Low return-to-normal: 2°F below setpoint
 - c) High alarm: 3°F above setpoint
 - d) High return-to-normal: 2°F above setpoint.
 - 3. AHU mixed air temperature (all values adjustable):
 - a) Low alarm: 45°F
 - b) Low return-to-normal: 46°F
 - c) High alarm: 90°F



- d) High return-to-normal: 89°F
- 4. Duct Pressure:
 - a) Low alarm: 0.5" w.g. below setpoint
 - b) Low return-to-normal: 0.25" w.g. below setpoint
 - c) High alarm: 0.5" w.g. above setpoint
 - d) High return-to-normal: 0.25" w.g. above setpoint
- 5. Space humidity:
 - a) Low alarm: 35%
 - b) Low return-to-normal: 40%
 - c) High alarm: 75%
 - d) High return-to-normal: 70%
- 6. Air Quality CO₂:
 - a) High alarm: 1,300 ppm
 - b) High return-to-normal: 1,000 ppm
- D. BAS System Failure Alarm: Generate alarm that reads "BAS System Failure". Alarm shall be generated when communication is lost to any controller or when any controller is determined to be in an abnormal state.

3.07 GRAPHIC SCREENS

- A. General:
 - 1. All Graphics shall be visible on all OWS displays in full screen mode without the use of scroll bars.
 - 2. All Graphics shall be printable with a blank/white background.
 - 3. All Graphics must have a unique background graphic, except Terminal Equipment Controllers. The color behind background graphic shall be the same for all graphics.
 - 4. All Graphics must contain all setpoints for the system represented. All displayed setpoints must be adjustable from the graphic and may not be hard coded in software.
 - 5. All Graphics must contain all physical points comprising the system.
 - 6. All Graphics shall include outside air sensor data.
 - 7. All relevant systems Graphics must contain a unique Graphical Link to the As-Built Sequence of Operations.
 - 8. All Graphics shall contain a Dynamic Graphical Links to the contract document As-Built mechanical, electrical and complete BAS drawing(s) for the represented system.
 - 9. All Graphics shall display any points that are currently in alarm with a graphical alarm representation that is consistent across all BAS projects to indicate the point is in alarm. All alarm points must be on a graphic.
 - 10. All animated Graphics shall accurately reflect the state of the equipment/device represented.



11. Provide zone level environmental index and building performance dashboard.
 12. The main building/site graphic must include a software emergency shutdown button. The software emergency shutdown button will shut down all HVAC systems within the building/site as described in the Sequences of Operation. Activation of the software shutdown button will be user level restricted.
- B. Floor Plan Screens: The contract document drawings will be used as the template for all floor plan graphic backgrounds.
1. Clearly display the building name and floorplan name at the top of each individual building floorplan graphic.
 2. Provide a campus map graphic (or edit existing graphic) to identify location of building(s) for this project with clickable links.
 3. Provide a per building floor plan graphic showing all thermographic color floorplans scaled to fit on one screen and designed to quickly evaluate building status. Include status off all major building systems and access to 'global' building setpoints.
 4. Provide two-dimensional thermographic color floor plan screens for each floor, wing, or tower of the building. Indicate the location of all equipment that is not located on the equipment room screens. Indicate all equipment zones with corresponding ON/OFF status. Indicate the location of temperature sensors associated with each temperature-controlled zone (i.e., VAV terminals, fan-coils, single-zone AHUs, etc.) on the floor plan screens. Display the space temperature point adjacent to each temperature sensor symbol. Use a distinct line or symbol to demarcate each terminal unit zone boundary. Use distinct colors to demarcate each air handling unit zone. Mechanical floor plan drawings will be made available to the user via a dynamic graphic link to the actual document. Indicate room numbers as provided by the Owner. Provide a drawing link from each space temperature sensor symbol and equipment symbol shown on the graphic floor plan screens to each corresponding equipment schematic graphic screen.
 5. Provide two-dimensional graphic floor plan screens for each mechanical equipment room and a plan screen of the roof. Indicate the location of each item of mechanical equipment. Provide a drawing link from each equipment symbol shown on the graphic plan view screen to each corresponding mechanical system schematic graphic screen.
 6. If multiple floor plans are necessary to show all areas, provide a graphic building key plan. Use elevation views and/or plan views as necessary to graphically indicate the location of all the larger scale floor plans. Link graphic building key plan to larger scale partial floor plans. Provide links from each larger scale graphic floor plan screen to the building key plan and to each of the other graphic floor plan screens. The key here is to assure all graphics can be linked to another and found dynamically by viewing a hierarchical tree like structure that contains all graphics in the system.



- C. System Schematic Screens:
1. Provide graphic system schematic screen for each controlled and monitored System and Sub-System.
 2. System graphics shall include flow diagrams with status, setpoints, current analog input and output values, operator commands, etc. as applicable.
 3. Operator adjustable points shall be adjustable through the graphic interface.
 4. General layout of the system shall be schematically correct and in the point of view as if an Operator were standing beside the most important access point for the system as physically installed.
 5. Input/output devices shall be shown in their schematically correct locations. Include appropriate engineering units for each displayed point value. Verbose names (English language descriptors) shall be included for each point on all graphics.
 6. Indicate all adjustable setpoints on the applicable system schematic graphic screen or, if space does not allow, on a supplemental linked-setpoint screen.
 7. For each sub-system (i.e. VAV box) provide a link to all other systems serving that system (i.e. HW System, VAV AHU). Include pertinent data from the serving system on the sub-system graphic (i.e. VAV AHU supply temperature at VAV box primary air intake).
 8. All valve and damper position indicators should read “100% open” when the valve or damper is actually fully open and “0% open” when the valve or damper is fully closed. Normally open (N/O) or normally closed (N/C) action of valve or damper actuator shall be indicated on the graphic.
 9. Indicate occupancy status and temperature (via color bar graphic) on each zone level equipment graphic.

END OF SECTION



SECTION 25 35 00 INSTRUMENTATION AND TERMINAL DEVICES FOR HVAC

GENERAL

1.01 SECTION INCLUDES:

- A. Description of Work
- B. Products Furnished but Not Installed Under this Section

1.02 DESCRIPTION OF WORK:

- A. Furnish and Install DDC instrumentation and control devices required supporting specified building automation system functions as detailed herein and Section 25 55 00.

PRODUCTS

2.01 NAMEPLATE SUBMITTAL

- A. A complete nameplate and labeling schedule shall be provided to the Owner for approval prior to creating any label or nameplate. – Naming convention to be followed, consult with Owner on questions.

2.02 MATERIALS AND EQUIPMENT

- A. General: Provide Direct Digital Control products in sizes and capacities indicated, consisting of valves, dampers, thermostats, clocks, controllers, sensors, and other components as required for complete installation, reviewed, and approved by the Owner or the Owner's representative. Except as otherwise indicated, provide manufacturer's standard materials and components as published in their product information; designed and constructed as recommended by manufacturer, and as required for application indicated.
- B. Instrument Pipe and Tube
 1. Hydronic and Instruments
 - a) Connection to Main Piping: Provide ½ inch minimum size thread-o-let, ½" x 2 inch brass nipple, and ½" ball valve for connection to welded steel piping. Provide tee fitting for other types of piping.
 - b) Remote Instruments: Adapt from ball valve to specified tubing and extend to remote instruments. Provide a union or otherwise removable fitting at ball valve so that connection to main can be cleaned with straight rod. Where manifolds with test ports are not provided for instrument, provide tees with ¼" FPT branch with plug for use as test port. Adapt from tubing size to instrument connection.
 - c) Line Mounted Instruments: Extend rigid piping from ball valve to instrument. Do not use close or running thread nipples. Adapt from ball valve outlet to instrument connection size. Provide a plugged



- tee if pipe makes 90 degree bend at outlet of valve to allow cleaning of connection to main with straight rod without removing instrument.
- d) Instrument Tubing: Seamless copper tubing, Type K or L, ASTM B 88; with cast-bronze solder joint fittings, ANSI B1.18; or wrought-copper solder-joint fittings, ANSI B16.22; or brass compression-type fittings. The solder shall be 95/5 tin antimony, or other suitable lead free composition solder. Tubing OD size shall be not less than the larger of ¼" or the instrument connection size.
 - e) Rigid Piping for Line Mounted Instruments: Schedule 40 threaded brass, with threaded brass fittings.
2. Low Pressure Air Instrument Sensing Lines
 - a) Connections: Use suitable bulkhead type fitting and static sensing tip for static pressure connections. Adapt tubing to instrument connection.
 - b) Tubing: Virgin polyethylene non-metallic tubing type FR, ASTM D 2737, and with flame-retardant harness for multiple tubing. Use compression or push-on brass fittings.
- C. Communication Wiring: All wiring shall be in accordance with the manufacturer's requirements, Division 26 and Section 25 5500.
1. The Contractor shall supply all communication wiring as detailed in Section 25 55 00.
 2. Local Supervisory LAN: For any portions of this network required under this section of the specification, contractor shall use Fiber or Category 5e of standard TIA/EIA (100/1000BaseT). Network shall be run with no splices and in separate conduit from any other wiring.
 3. Primary and Secondary Controller LANs: Communication wiring shall be individually 100% shielded pairs per manufacturers recommendations for distances installed, with overall PVC cover, Class 2, plenum-rated run with no splices and separate from any other wiring. Shield shall be terminated and wiring shall be grounded as recommended by BC manufacturer.
- D. Signal Wiring: Contractor shall run all signals wiring in accordance with National Electric Codes, Division 26 and Section 25 5500.
1. Signal wiring to all field devices, including, but not limited to, all sensors, transducers, transmitters, switches, etc. shall be per manufacturer's requirements. Signal wiring shall be run with no splices and separate from all other wiring above thirty (30) volts.
 2. Signal wiring shield shall be grounded at the controller end only unless otherwise recommended by the controller manufacturer.
- E. Low Voltage Analog Output Wiring: Contractor shall run all low voltage control wiring in accordance with National Electric Codes, Division 26 and Section 25 55 00. All wire insulation shall be color-coded and labeled for ease of identification.
1. Low voltage control wiring shall be per manufacturer's requirements. Low voltage control wiring shall be run with no splices separate from



- any wiring above thirty (30) volts.
- F. Control Panels: Provide control panels with suitable brackets for wall mounting for each control system. Locate panel adjacent to systems served.
1. Fabricate panels of 16-gage furniture-grade steel, or 6063-T5 extruded aluminum alloy, totally enclosed on four sides, with hinged door and keyed lock, with manufacturer's standard shop-painted finish and color.
 2. Provide UL-listed cabinets for use with line voltage devices.
 3. Control panel shall be completely wired prior to delivery and all electrical connections made to a labeled terminal strip. Control panel shall have standard manufacturer's color.
 4. All gauges and control components shall be identified by means of nameplates.
 5. All control wiring shall be run neatly and orderly in open slot wiring duct with cover.
 6. Complete wiring termination drawings shall be mounted in or adjacent to the panel.
 7. Unitized cabinet type for each system under automatic control. Provide quantity of enclosures required to house all relays, transducers, solenoid valves, pneumatic devices, and other interface controls. Mount temperature, humidity, airflow and pressure indicators, (or operator interface display with keypad), pressure gauges, pilot lights, pushbuttons and switches flush on cabinet panel face. All transformers and power supplies shall be mounted outside of the central panel. Provide laminated nameplates for all devices utilizing tag name as submitted on shop drawings. Mechanically fasten nameplates to panel. Self-adhesive type nameplates are not acceptable.
 8. Provide NEMA-1 general-purpose enclosure for all applications where panel will be installed in relatively dust free and dry spaces. All control panels for use in mechanical rooms, wash-down locations or installed outdoors shall be rated NEMA-4. All cabinets shall use a common key. Provide means of storing control system instructions and drawings inside cabinet.
 9. Finish: Factory applied enamel, except that panels in finished spaces shall be primed for field painting.
 10. Provide surface mounted or freestanding, steel supported types for mechanical equipment rooms. Provide fully recessed wall-mounted types elsewhere.
 11. All panels shall be fully recessed in walls in public spaces, where possible.
 12. Interior arrangement of control panel components shall be such that tubing and wire raceways shall be separated and aligned horizontally and vertically, in a fashion that allows for an organized appearance and a practical means for the tubing/wire to exit the raceway to its intended component.



13. All tubing shall enter the panel through standard bulkhead compression fittings. Poly tubing may be run in conduit and enter panels via conduit fittings. All tubing lines shall be labeled at both ends of the tubing.
 14. All wire shall enter panels via conduit fittings. All wires shall terminate on terminal blocks and then continue from the terminal block to the device. Direct connection to the device is not permitted. Use of wire nuts is not permitted, except in applications in which a control device is provided from the factory with "pigtails". All wires shall be labeled at both ends of the terminal blocks. All penetrations of the BAS or outboard gear panels in mechanical rooms shall be from the bottom of the enclosure with wire-way and conduit stubs from the wire-way up to the panel.
 15. Power Supplies:
 - a) Provide a regulated, protected power supply as required with the ability to produce at least 33 percent more current than required by the transmitters and controls being installed. Output regulation shall be less than 0.5 mV. There shall be no overshoot on turn ON or OFF. The operating temperature shall be minus 20 to plus 70 degrees C.
 - b) The BAS Contractor shall certify in writing at the time of shop drawing submittal that the DDC equipment provided will not cause, as a result of its operation, either directly or indirectly, electrical interference to be induced into the building's electrical power systems.
 16. Class II transformers shall be used.
- G. Refer to Sections 25 5500 and Division 26 for means, methods and materials. Provide 120-volt power wiring from dedicated circuit breakers in electrical panels to BAS control panels. Provide necessary transformers. Coordinate with Division 26. See Section 25 55 00 for power quality requirements of each Control Panel circuit.
 - H. Control and Signal Circuits: Per NEC Article 725 (excluding thermocouple wiring). Control or signal circuits not run entirely in conduit, in areas classified as plenum space and vertical shafts shall be energized from listed Class 2 power supplies and shall be installed in Type "CL2P" listed plenum cable exclusively. Plenum rated cable shall be permitted in applications above an accessible ceiling or in between drywall where there is no insulation.
 - I. Provide all power and control wiring exposed outdoors, within rigid conduit properly labeled as BAS wiring. All power and control wiring above inaccessible ceilings within finished spaces, in drywall partitions with insulation or in block walls, in mechanical spaces and in vertical shafts shall be installed in electric metallic tubing (EMT).
 - J. Classify line (120 volt) and low (below 120 volt) voltage wiring from BAS and other control panels to control devices as control wiring.
 - K. Low Voltage Control Wiring: Wire shall be compatible with specific



application and in accordance with Division 26.

- L. For Hazardous location circuits as delineated in the design documents, refer to NFPA Article 500 for installation requirements.
- M. All cables shall be run parallel with structure, properly bundled, mounted (J Hooks) and secured every five feet. Provide labels every 20 feet (minimum) to identify associated system (i.e., BAS).

PART 3. EXECUTION

3.01 INSTALLATION OF CONTROL SYSTEMS:

- A. Plenum Wiring: All low voltage wiring external to control panels shall be in conduit, unless pre-approved. Conduit type, sizing, and installation requirements shall conform to NEC, Division 26 and Section 25 5500.
 - 1. Installation of wiring shall generally follow building lines. Run in a neat and orderly fashion, bundled where applicable, and completely suspended (strapped to rigid elements or routed through wiring J rings) away from areas of normal access. Tie and support conductors neatly with suitable nylon ties. Conductors shall not be supported by the ceiling system or ceiling support system. Conductors shall be pulled tight and be installed as high as practically possible in ceiling cavities. Wiring shall not be laid on any adjacent component or structure. Conductors shall not be installed between the top cord of a joist or beam and the bottom of roof decking. Contractor shall be fully responsible for noise immunity and rewire in conduit if electrical or RF noise affects performance. Under no circumstances will exposed splices be permitted.

3.02 NAMEPLATES

- A. Provide engraved phenolic or micarta nameplates for all equipment, components, and field devices furnished. Nameplates shall be 1/8 thick, black, with white center core, and shall be minimum 1" x 3", with minimum 1/4" high block lettering. Nameplates for devices smaller than 1" x 3" shall be attached to adjacent surface.
- B. Each nameplate shall at a minimum include the object name of the device or sensor.
- C. For all Variable Speed Drives (VSDs/VFDs), provide an additional engraved nameplate at the drive indicating the location of the controlled variable when the controlled variable is not adjacent to the drive.

3.03 TESTING EQUIPMENT

- A. Contractor shall test and calibrate all signaling circuits of all field devices to ascertain that required digital and accurate analog signals are transmitted, received, and displayed at system operator terminals, and make all repairs and recalibrations required to complete testing successfully. The contractor shall be responsible for test equipment required to perform these tests and calibrations. Test equipment used for testing and calibration of field devices



shall be at least twice as accurate as respective field device (e.g., if field device is +/-0.5% accurate, test equipment shall be +/-0.25% accurate over same range).

END OF SECTION



25 35 13 ACTUATORS AND OPERATORS

GENERAL

1.01 SECTION INCLUDES:

- A. Description of Work
- B. Valve Actuators and Operators
- C. Damper Actuators and Operators

1.02 DESCRIPTION OF WORK:

- A. Furnish and Install DDC instrumentation and control devices required supporting specified building automation system functions as detailed herein and Section 25 55 00.

PRODUCTS

2.01 ACTUATORS

A. General:

1. Actuators shall be either modulating, 2-position or spring return as indicated in the applicable control sequence.
2. As indicated in the applicable specification, all fail-safe operations shall require mechanical spring return or capacitive power generation or UPS power delivery for operation during the fail-safe condition.
3. Size actuators and linkages to operate their appropriate dampers or valves with a single actuator with sufficient reserve torque or force to provide smooth modulating action or 2-position action as specified.
4. The Owner must preapprove multiple actuators for any single application.
5. Select spring-return actuators with manual override to provide positive shut-off of devices as they are applied.
6. Actuators relying on batteries for any operation are not acceptable.
7. All electronic actuators shall be UL listed.

B. Damper and Valve Actuators:

1. Ambient Operating Temperature Limits: -10 to 150°F (-12.2 to 66 °C)
2. Two Position Electric Actuators: Low voltage or line voltage with spring return.
3. Electronic Actuators: Provide actuators with spring return for two-position (24v), 0-5 VDC, 0-10 VDC, 2-10VDC, 4-20 mA, or PWM input (subject to restrictions) as required. Actuators shall travel full stroke in less than 90 seconds for non-critical applications and travel less than 3 seconds for fast acting critical applications. Actuators shall be designed for a minimum of 60,000 full cycles at full torque and be UL 873 listed.



Provide stroke indicator. Actuators shall have a positive positioning circuit. When two actuators are required in parallel or in sequence, provide an auxiliary actuator driver. Actuators shall have current limiting motor protection. Actuators shall have manual override where indicated.

4. Close-Off Pressure: Provide the minimum torque required, and spring return for fail positioning (unless otherwise specifically indicated) sized for required close-off pressure. Required close-off pressure for two-way water valve applications shall be 150% of the shutoff head of associated pump. Required close-off rating of air damper applications shall be shutoff pressure of associated fan, plus 10 percent.
5. Acceptable Manufacturers: Subject to compliance with requirements, approved manufacturers are as follows:
 - 1) Bray
 - 2) Siemens
 - 3) Substitutions: As allowed per Division 01.

C. Quarter-Turn Actuators for Ball and Butterfly Valves and Air Valves:

1. Electric Actuation:
 - a) Motor: Suitable for 120 or 240 VAC single-phase power supply. Insulation shall be NEMA Class F or better. Motor shall be rated for 100 percent duty cycle. Motors shall have inherent overload protection.
 - b) Gear-Train. Motor output shall be directed to a self-locking gear drive mechanism. Gears shall be rated for torque input exceeding motor locked rotor torque.
 - c) Wiring: Power and control wiring shall be wired to a terminal strip in the actuator enclosure
 - d) Failsafe Positioning: Actuators shall be spring return type for failsafe positioning.
 - e) Enclosure: Actuator enclosure shall be NEMA-4 rated and shall have a minimum of two threaded conduit entries. Provide an enclosure heater for actuators located outside of buildings.
 - f) Limit Switches: Travel limit switches shall be UL and CSA approved. Switches shall limit actuator in both open and closed positions.
 - g) Mechanical Travel Stops: The actuator shall include mechanical travel stops of stainless steel construction to limit actuator to specific degrees of rotation.
 - h) Manual Override: Actuators shall have manual actuator override to allow operation of the valve when power is off. For valves 4 inches and smaller the override may be a removable wrench or lever or geared hand-wheel type. For larger valves, the override shall be a fixed geared hand-wheel type. An automatic power cut-off switch shall be provided to disconnect power from the motor when the



- hand-wheel is engaged for manual operation.
- i) Valve Position Indicator: A valve position indicator with arrow and open and closed position marks shall be provided to indicate valve position.
 - j) Torque Limit Switches: Provide torque limit switches to interrupt motor power when torque limit is exceeded in either direction of rotation.
 - k) Position Controller: For valves used for modulating control, provide an electronic position driver capable of accepting 4-20 mA, 0-10 VDC, 2-10 VDC, and 135-Ohm potentiometer.
 - l) Ambient Conditions: Actuator shall be designed for operation from -22 to 122 °F ambient temperatures with 0 to 100 percent relative humidity.
 - m) Timing: Actuators shall travel full stroke in less than 90 seconds for non-critical applications and travel less than 3 seconds for fast acting critical applications.
 - n) Acceptable Manufacturers:
 - 1) Bray
 - 2) Siemens
 - 3) Substitutions: As allowed per Division 01

EXECUTION

3.01 GENERAL

- A. Examine areas and conditions under which control systems are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in a manner acceptable to the BAS Contractor or Installer.
- B. Refer to Section 25 35 00 for general requirements.

3.02 INSTALLATION OF CONTROL SYSTEMS:

- A. Plenum Wiring: All low voltage wiring external to control panels shall conform to NEC, Division 26 and Section 25 55 00.
 - 1. Installation of wiring shall generally follow building lines. Run in a neat and orderly fashion, bundled where applicable, and completely suspended (strapped to rigid elements or routed through wiring J rings) away from areas of normal access. Tie and support conductors neatly with suitable nylon ties. Conductors shall not be supported by the ceiling system or ceiling support system. Conductors shall be pulled tight and be installed as high as practically possible in ceiling cavities. Wiring shall not be laid on any adjacent component or structure. Conductors shall not be installed between the top cord of a joist or beam and the bottom of roof decking. Contractor shall be fully responsible for noise immunity and rewire in conduit if electrical or RF noise affects performance. Under no circumstances will exposed splices be permitted.



- B. Electric and Electronic Damper Actuators:
 - 1. For low-leakage dampers with seals, mount actuator with a minimum 5° travel available for damper seal tightening.
 - 2. To compress seals when spring-return actuators are used on normally closed dampers, power actuators to approximately 5° open position, manually close the damper, and then tighten linkage.
 - 3. Check operation of damper-actuator combination to confirm that actuator modulates damper smoothly throughout stroke to both open and closed positions.
- C. Control Valves: Install so that actuators, wiring, and tubing connections are accessible for maintenance. Where possible, install with valve stem axis vertical, with operator side up. Where vertical stem position is not possible, or would result in poor access, valves may be installed with stem horizontal. Do not install valves with stem below horizontal, or down. Always refer to manufacturer's recommended installation best practices prior to installation.

END OF SECTION



25 35 16 SENSORS AND TRANSMITTERS

GENERAL

1.01 SECTION INCLUDES:

- A. Description of Work
- B. General Field Device Requirements
- C. Sensors
- D. Meters
- E. Electric Control Components; Switches, EP Valves, Thermostats, Relays, Smoke Detectors, etc.
- F. Transducers
- G. Transmitters
- H. Voltage and Phase Monitors
- I. Air Flow Measuring Stations (AFMS)
- J. Current Switches

1.02 GENERAL FIELD DEVICE REQUIREMENTS

- A. Provide field devices for input and output of digital (binary) and analog signals into controllers (BCs, AACs, ASCs). Provide signal conditioning for all field devices as recommended by field device manufacturers, and as required for proper operation in the system.
- B. It shall be the BAS Contractor's responsibility to ensure that all field devices are compatible with controller hardware and software.
- C. Field devices specified herein are generally 'two-wire' type transmitters, with power for the device to be supplied from the respective controller. If the controller provided is not equipped to provide this power or is not designed to work with 'two-wire' type transmitters, or if field device is to serve as input to more than one controller, or where the length of wire to the controller will unacceptably affect the accuracy, the Contractor shall provide 'four-wire' type equal transmitter and necessary regulated DC power supply or 120 VAC power supply, as required. All such examples shall be coordinated and agreed upon with the BAS Contractor.
- D. For field devices specified hereinafter that require signal conditioners, signal boosters, signal repeaters, or other devices for proper interface to controllers, Contractor shall furnish and install proper device, including 120V power as required. Such devices shall have accuracy equal to, or better than, the accuracy listed for respective field devices. All such examples shall be coordinated and agreed upon with the BAS Contractor.
- E. Accuracy: As stated in this Section, accuracy shall include combined effects of nonlinearity, non-repeatability, and hysteresis. Refer to Section 25 55 00 for reporting performance requirements.



PRODUCTS

2.01 TEMPERATURE SENSORS (TS)

- A. Sensor Range: When matched with A/D converter of BC, AAC/ASC, or SD. Where thermistors are used, the stability shall be better than 0.25°F over 5 years.
- B. Room Temperature Sensor: Shall be an element contained within a ventilated cover, suitable for wall mounting. Provide insulated base. Following sensing elements are acceptable:
 - 1. Sensing element shall be platinum RTD, thermistor, or integrated circuit, +/- 0.4°F accuracy at calibration point. Provide setpoint adjustment where indicated. The setpoint adjustment shall be a warmer/cooler indication that shall be scalable via the BAS (initial range of +/- 2°F).
 - 2. Provide an occupancy override button on the room sensor enclosure where indicated. This shall be a momentary contact closure
 - 3. Provide temperature indication via an LCD readout where indicated.
- C. Single-Point Duct Temperature Sensor: Shall consist of sensing element, junction box for wiring connections and gasket to prevent air leakage or vibration noise. Temperature range as required for resolution indicated in paragraph A.
 - 1. Sensing element shall be platinum RTD, thermistor, or integrated circuit, +/- 0.2°F accuracy at calibration point
 - 2. For duct mounted installations, flange mount sensor to side of duct using manufacturer's standard recommendations and select probe lengths suitable for sensor location at center of duct.
- D. Averaging Duct Temperature Sensor: Shall consist of an averaging element, junction box for wiring connections and gasket to prevent air leakage. Provide sensor lengths and quantities to result in one lineal foot of sensing element for each three square feet of cooling coil/duct face area. Temperature range as required for resolution indicated in paragraph A.
 - 1. Sensing element shall be platinum RTD, or thermistor, +/- 0.2°F accuracy.
 - 2. For duct mounted installations, flange mount sensor to side of duct using manufacturer's standard recommendations and select minimum probe length of one linear foot per three square feet of cross sectional area. Install sensor in serpentine fashion across duct area with no contact with other devices or coil surfaces.
- E. Liquid Immersion Temperature Sensor: Shall include brass thermowell, sensor and connection head for wiring connections.
 - 1. Sensing element shall be platinum RTD, thermistor, or integrated circuit, +/- 0.4°F accuracy at calibration point.



- F. Surface Mount Temperature Sensor: Shall include electrical utility box, sensor and connection head for wiring connections, and suitable for installation under insulation. Provide thermally conductive paste (compatible with pipe material) at pipe contact point. These may only be used where specifically indicated, typically on a temporary basis.
 - 1. Sensing element shall be platinum RTD, thermistor, or integrated circuit, +/- 0.4°F accuracy at calibration point.
- G. Outside Air Sensors: Shall consist of a sensor, sun shield, utility box, and watertight gasket to prevent water seepage. Temperature range shall be as require for resolution indicated in Paragraph A
 - 1. Sensing element shall be platinum RTD, thermistor, or integrated circuit, +/- 0.4°F accuracy at calibration point.

2.02 HUMIDITY TRANSMITTERS

- A. Units shall be suitable for duct, wall (room) or outdoor mounting. The unit shall be a two-wire transmitter utilizing bulk polymer resistance change or thin film capacitance change humidity sensor. Unit shall produce linear continuous output of 4-20 mA for percent relative humidity (% RH). A combination temperature and humidity sensor may be used for zone level monitoring. Sensors shall have the following minimum performance and application criteria:
 - 1. Input Range: 0 to 100% RH.
 - 2. Accuracy (% RH): +/- 2% (when used for enthalpy calculation, dew-point calculation or humidifier control) or +/- 3% (monitoring only) between 20-90% RH at 77°F, including hysteresis, linearity, and repeatability.
 - 3. Sensor Operating Range: As required by application
 - 4. Long Term Stability: Less than 1% drift per year.
- B. For duct mounted installations, flange mount sensor to side of duct using manufacturer's standard recommendations and select probe lengths suitable for sensor location at center of duct.
- C. Accessories: Duct-mounting plate, quick mount duct flange adapter, sensor dust filter, and single point calibrator for on-line/on-site calibration.
- D. Provide other accessories as required to protect sensors for up to 2500 fpm velocities.

2.03 PRESSURE TRANSMITTERS

- A. General Purpose - Liquid:
 - 1. General: Loop powered two-wire transmitter.
 - 2. Output: two-wire 4-20 mA output with zero and span adjustments.
 - 3. Overall Accuracy: less than 0.1% of span.
 - 4. Housing: Polymer housing suitable for surface mounting.
 - 5. Valve Bypass (where required by AU): Provide a five-valve bypass kit for calibration. Kit shall include high- and low-pressure isolation valves,



high- and low-pressure vent valves, and a bypass valve contained in a NEMA-1 enclosure. Enclosure shall be mounted no higher than 6 feet above floor level.

6. Range: Select for specified setpoint to be between 25% and 75% full-scale.
- B. General-Purpose Low-Pressure Air: Generally, for use in static measurement of duct pressure or constant volume air velocity pressure measurement where the range is applicable.
1. General: Loop powered two-wire differential capacitance cell-type transmitter.
 2. Output: two-wire 4-20 mA output with zero adjustment.
 3. Overall Accuracy: Plus or minus 1%.
 4. Minimum Range: 0.1 in. w.c.
 5. Maximum Range: 10 inches w.c.
 6. Housing: Polymer housing suitable for surface mounting.
 7. Acceptable Manufacturers: Johnson Controls, Schneider Electric, Siemens, Setra, and Veris Industries. Substitutions shall be allowed per Division 01.
 8. Static Sensing Element: Pitot-type static pressure sensing tips similar to Dwyer model A-301 and connecting tubing.
 9. Range: Select for specified setpoint to be between 25% and 75% full-scale.
- C. General Purpose Low Pressure/Low Differential Air: Generally, for use in static measurement of space pressure or constant volume air velocity pressure measurement where the range is applicable.
1. General: Loop powered, two-wire differential capacitance cell type transmitter.
 2. Output: Two-wire 4-20 mA output with zero adjustment.
 3. Overall Accuracy: Plus or minus 1%.
 4. Minimum Range: 0 in. w.c.
 5. Maximum Range: 0.1, 0.25, or 0.5 inches w.c.
 6. Housing: Polymer housing suitable for surface mounting.
 7. Static Sensing Element: Pitot-type static pressure sensing tips similar to Dwyer model A-301 and connecting tubing.
 8. Range: Select for specified setpoint to be between 25% and 75% full-scale.
- D. VAV/CAV Velocity Pressure: Generally, for use to measure volume of air velocity pressure measurement where the range is applicable.
1. General: Loop powered two-wire differential capacitance cell type transmitter.
 2. Output: Two-wire, 4-20 mA output with zero adjustment.
 3. Overall Accuracy: Plus or minus 0.25%



4. Minimum Range: 0 in. w.c.
5. Maximum Range: 1-inch w.c.
6. Housing: Polymer housing suitable for surface mounting.
7. Range: Select for minimum range that will accept the maximum velocity pressure expected.

2.04 DIFFERENTIAL PRESSURE SWITCHES (DPS)

- A. General Service - Air: Diaphragm with adjustable setpoint and differential and snap acting Form C contacts rated for the application. Provide manufacturer's recommended static pressure sensing tips and connecting tubing
- B. General Service - Water: Diaphragm with adjustable setpoint, 2 psig or adjustable differential and snap-acting Form C contacts rated for the application. 0°F to 160°F operating temperature.

2.05 PRESSURE SWITCHES (PS)

- A. Diaphragm or bourdon tube with adjustable setpoint and differential and snap-acting Form C contacts rated for the application. Pressure switches shall be capable of withstanding 150% of rated pressure.

2.06 PHASE-VOLTAGE-FREQUENCY MONITOR

- A. Monitoring of equipment operating at 480V or below shall be accomplished using a device capable of directly monitoring voltage (line to line, line to neutral, phase to phase), current (each phase), and instantaneous kW demand or a direct connection to the facility distributed electrical SCADA system via MODBUS TCP.

2.07 CURRENT SWITCHES (CS)

- A. Clamp-On Design Current Operated Switch (for Constant Speed Motor Status Indication)
 1. Range: 1.5 to 150 Amps.
 2. Trip Point: Adjustable.
 3. Switch: Solid state, normally open, 1 to 135 VAC or Vdc, 0.3 Amps. Zero off state leakage.
 4. Lower Frequency Limit: 6 Hz.
 5. Trip Indication: LED
 6. Approvals: UL, CSA
 7. Max. Cable Size: 350 MCM
 8. Acceptable Manufacturers: Veris Industries, Senva. Substitutions shall be allowed per Division 01.
- B. Clamp-on Wire Through Current Switch (CS/CR) (for Constant Speed Motors): Same as CS with 24V command relay rated at 5A @ 240 VAC resistive, 3A @ 240 VAC inductive, load control contact power shall be



induced from monitored conductor (minimum conductor current required to energize relay 5A, max. rating of 135A). Acceptable Manufacturers shall be Veris Industries Model # H938/735; or Senva C-2330. Substitutions shall be allowed per Division 01.

1. When used for single-phase devices, provide the CS/CR in a self-contained unit in housing similar with override switch to Kele RIBX. Substitutions shall be allowed per Division 1.
- C. Clamp-On Design Current Operated Switch for Variable Speed Motor Status Indication
1. Range: 1.5 to 135 Amps.
 2. Trip Point: Self-calibrating based on VA memory associated with frequency to detect loss of belt with subsequent increase of control output to 60 Hz.
 3. Switch: Solid state, normally open, 1 to 135 VAC or VDC, 0.3 Amps. Zero off state leakage.
 4. Frequency Range: 5-75 Hz
 5. Trip Indication: LED
 6. Approvals: UL, CSA
 7. Max. Cable Size: 350 MCM
 8. Acceptable Manufacturers: Senva or Veris Industries. Substitutions shall be allowed per Division 01.
- D. Clamp-On Wire Through Current Switch (CS/CR) (for Variable Speed Motors): Same as CS with 24v command relay rated at 5A @ 240 VAC resistive, 3A @ 240 VAC inductive, load control contact power shall be induced from monitored conductor (minimum conductor current required to energize relay 5A, max. rating of 135A). An acceptable manufacturer shall be Senva or Veris Industries. Substitutions shall be allowed per Division 01.
- E. Variable Speed Status: Where current switches are used to sense the status for variable speed devices, the CT shall include on-board VA/Hz memory to allow distinction between a belt break and subsequent ramp up to 60 Hz, versus operation at low speed. The belt break scenario shall be indicated as a loss of status and the operation at low speed shall indicate normal status.

2.08 CURRENT TRANSDUCER (CT)

- A. Clamp-On Design Current Transducer (for Motor Current Sensing)
1. Range : 1-10 Amps minimum, 20-200 Amps maximum ; Range shall match application
 2. Trip Point: Adjustable
 3. Output: 4-20 mA.
 4. Accuracy: $\pm 0.2\%$ from 20 to 100 Hz.
 5. Acceptable Manufacturers: Senva or Veris. Substitutions shall be allowed per Division 01.



2.09 OUTDOOR AIR STATIC PRESSURE SENSING TIP

- A. Pressure sensor: Pressure sensing tip shall be designed to minimize the effects of wind and resulting velocity pressure up to 80 mph.
- B. Low Air Pressure Surge Dampener: 30-second time constant. Acceptable manufacturer shall be Amphenol Advanced Sensors. Substitutions shall be allowed per Division 01.

2.10 LIGHT SENSOR

- A. Units shall be suitable for wall (room) or outdoor mounting. Unit shall be three-wire transmitter. Unit shall produce linear continuous output of 4-20 mA for foot-candle (fc) reading. Sensors shall have the following minimum performance and application criteria:
 - 1. Input Range: 50 – 750 fc.
 - 2. Accuracy: +/- 1%.
 - 3. Operating Voltage: 12 – 24 VDC.
 - 4. Sensor Operating Range: As required by application

2.11 CONTINUOUS LEVEL TRANSMITTERS

- A. Capacitance Type
 - 1. Provide a loop powered, continuous capacitance type level transmitter with adjustable span and zero.
 - 2. Output: 4-20 mA.
 - 3. Probe: Fluoropolymer coated stainless steel rod or cable. Provide cable probe with end attachment hardware or weight.
 - 4. Electrical Enclosure: NEMA 4 (indoor application), NEMA 6 (outdoor application).
 - 5. Approvals: UL or CSA.
 - 6. Accuracy: $\pm 1\%$ of calibrated span.
 - 7. Process Connection: MPT or ANSI Flange as required.
- B. Ultrasonic Type
 - 1. Provide a non-contacting, temperature compensating, narrow beam, ultrasonic type level transmitter with adjustable span and zero.
 - 2. Output: 4-20 mA.
 - 3. Transducer Materials: PC/ABS, Polypropylene, PVC and/or Teflon.
 - 4. Electrical Enclosure: NEMA-4X, Type 6.
 - 5. Approvals: UL, CE or CSA.
 - 6. Accuracy: $\pm .5\%$ of calibrated span.

2.12 INSERTION TYPE TURBINE METER FOR WATER SERVICE

- A. Turbine Insertion Flow Meter sensing method shall be impedance sensing (iron magnetic and non-photoelectric), with volumetric accuracy of +/- 2% of reading over the entire operating range.



- B. Turbine Insertion Flow Meter shall have maximum operating pressure of 400 psi and maximum operating temperature of 200°F continuous (220°F peak).
- C. All wetted metal parts shall be constructed of 316-stainless steel.
- D. Flow meter shall meet or exceed the accuracy, head loss, flow limits, pressure and material requirements of the AWWA standard C704-70 for the respective pipe or tube size.
- E. Analog outputs shall consist of non-interactive zero and span adjustments, a DC linearly of 0.1% of span, voltage output of 0-10 V, and current output of 4-20 mA.
 - 1. Install in water systems with a minimum of straight length unobstructed flow per manufacturer's requirements.

2.13 ULTRASONIC WATER SERVICE FLOW METER

- A. Clamp-On Ultrasonic Flow Meter: The ultrasonic flow meter shall be a transit-time non-invasive clamp-on type in which transducers clamp on the exterior surface of the pipe. The flow meter shall use Time-Domain Expansion Technology that allows for extremely accurate measurement of upstream and downstream arrival time differentials. The achievable field accuracy shall be 1% of rate or better. The repeatability of the flow meter shall be 0.5% of rate. The flow meter shall be able to measure bi-directional velocities.

2.14 VORTEX SHEDDING FLOW METER FOR LIQUID AND GAS SERVICE:

- A. Output: 4-20 mA, 0-10 VDC, 0-5 VDC
- B. Maximum Fluid Temperature: 800 °F (427 °C)
- C. Wetted Parts: Stainless Steel
- D. Housing: NEMA 4 (indoor applications), NEMA 6 (outdoor applications)
- E. Turndown: 10:1 minimum.
- F. Accuracy: 0.5% of calibrated span for liquids, 1% of calibrated span for gases.
- G. Body: Wafer style or ANSI flanged to match piping specification.

2.15 AIRFLOW MEASURING STATIONS (AFMS)

- A. Pitot Tube Grids: Provide an array of velocity pressure sensing elements with averaging manifolds and air straightening vanes packaged in a sheet metal casing. Distribute sensing elements in accordance with ASHRAE for traversing ducts. Provide taps to connect tubing from instrumentation. Label AFM with drawing number designation, design flow, velocity pressure, and pressure drop. Application of pitot grids shall be allowed only where minimum expected flow is greater than 30% or maximum flow
- B. Vortex Shedding Grid: Provide an array of vortex shedding elements designed to produce stable vortices that are linear with air velocity. Provide the electronics to totalize the pulses and output average velocity proportional to an output signal of 4-20ma.



1. Sensor Accuracy: $\pm 2\%$
2. Electronics Accuracy: $\pm 0.5\%$
3. Range: Select minimum range to accommodate the expected flow range of the project
4. Temperature Limits: 20-140°F
5. Acceptable Manufacturer: Tek-Air Vortek VT series. Substitutions shall be allowed per Division 01.

2.16 AIR VELOCITY PRESSURE SENSORS (INSERTION TYPE)

- A. Single or Multi-Point Averaging (as indicated): Sensing tip shall be for insertion into duct with mounting flange and push on tube connections. Material shall be suitable to the application.

2.17 CO₂ SENSORS/TRANSMITTERS (CO₂)

- A. CO₂ sensors shall use silicon based, diffusion aspirated, infrared single beam, dual-wavelength sensor.
- B. Accuracy: $\pm 2\%$ full scale to 1400 ppm.
- C. Stability: 5% over 5 years.
- D. Output: 4-20 mA, 0-10 VDC or relay.
- E. Mounting: Duct or Wall as indicated.

2.18 ELECTRIC CONTROL COMPONENTS

- A. Control Relays: All control relays shall be UL listed, with contacts rated for the application, and mounted in minimum NEMA-1 enclosure for indoor locations, NEMA-4 for outdoor locations.

1. Control relays for use on electrical systems of 120 volts or less shall have, as a minimum, the following:
 - a) AC coil pull-in voltage range of +10%, -15% or nominal voltage.
 - b) Coil sealed Volt-Amperes (VA) not greater than four (4) VA.
 - c) Silver cadmium Form C (SPDT) contacts in a dustproof enclosure, with 8 or 11 pin type plug.
 - d) LED pilot light indication of power-to-coil and coil retainer clips.
 - e) Coil rated for 50 and 60 Hz service.
 - f) Acceptable Manufacturers: Relays shall be IDEC or Functional Devices RIB. Substitutions shall be allowed per Division 01.
2. Relays used for across-the-line control (start/stop) of 120V motors, 1/4 HP, and 1/3 HP, shall be rated to break minimum 10 Amps inductive load. Relays shall be IDEC or Functional Devices RIB. Substitutions shall be allowed per Division 01. Whatever spec/code is required, maybe list 150% requirement (more money typ).
3. Relays used for stop/start control shall have low voltage coils (30 VAC or less) and shall be provided with transient and surge suppression devices at the controller interface.

- B. Control Transformers: Furnish and install control transformers as required.



Control transformers shall be machine tool type and shall be US and CSA listed. Primary and secondary sides shall be fused in accordance with the NEC. The transformer shall be of proper size for application not to exceed 100VA and mounted in minimum NEMA-1 enclosure.

- C. Electric Push Button Switch: Switch shall be momentary contact, oil tight, push button, with number of N.O. and/or N.C. contacts as required. Contacts shall be snap-action type and rated for minimum 120 VAC operation.
- D. Electric Selector Switch (SS): Switch shall be maintained contact, NEMA ICS 2, oil-tight selector switch with contact arrangement, as required. Contacts shall be rated for minimum 120 VAC operation.
- E. General Purpose Power Contactors: NEMA ICS 2, AC general-purpose magnetic contactor. ANSI/NEMA ICS 6, NEMA type 1 enclosure. Limit Switches (LS): Limit switches shall be UL listed, SPDT or DPDT type, with adjustable trim arm. Limit switches shall be as manufactured by Square D, Allen Bradley. Substitutions shall be allowed per Division 01.
- F. Low Temperature Detector ('Freezestat') (FZ): Low temperature detector shall consist of a 'cold spot' element which responds only to the lowest temperature along any one foot of entire element, minimum bulb size of 1/8" x 20' (3.2mm x 6.1m), junction box for wiring connections and gasket to prevent air leakage or vibration noise, DPST (4 wire, 2 circuit) with manual reset. Temperature range 15 to 55°F (-9.4 to 12.8°C), factory set at 38°F. Provide one thermostat for every 20 square feet of coil surface.
- G. Manual Time Switch: Switch shall be spring wound, manually set time switch for the control of electrical current. Contacts shall be rated for minimum 120 VAC operation.
- H. Pilot Light: Panel-mounted pilot light shall be NEMA ICS 2 oil tight, transformer type, with screw terminals, push-to-test unit, LED type, rated for 120 VAC.
- I. Surface-Mounted Thermostat: Surface-mounted thermostat shall consist of SPDT contacts, operating temperature range of 50 to 150° F (10 to 65°C), and a minimum 10°F fixed setpoint differential.

2.19 REFRIGERANT MONITOR

- A. General: Contractor shall provide a refrigerant sensitive infrared-based stationary refrigerant gas leak monitor system designed to continuously measure refrigerants. The alarm system shall comply with ANSI/ASHRAE 15 and local code requirements. Device start-up and calibration shall be performed by certified factory/manufacturer's representative.
- B. The refrigerant monitor shall be capable of monitoring multiple refrigerant gas compounds at multiple locations. Accuracy shall be maintained within ambient environmental ranges of 0°C. through 50°C., (32°F. through 122°F.) and 5% through 90% relative humidity, non-condensing.
- C. The refrigerant monitor shall automatically and continuously monitor the



areas through a sample draw type tubular pick up system with an internal pump and filter. The installation of the monitoring control and the tubing shall be in strict accordance with the manufacturer's instructions. The location, routing, and final position of the sample tubes shall be submitted to the engineer with all necessary shop drawings and monitor specifications and installation instructions. Each of the sampling tubes shall have end of line filters.

- D. Factory certification of the calibrations shall be provided with the O&M manuals.
- E. The monitor shall continuously display the refrigerant concentration level and alarm status.
- F. The monitor shall have a gasketed, hinged front cover. Conduits and tube connections shall be located on the bottom of the enclosure. The enclosure shall have a rust and corrosion resistant finish.
- G. All alarm conditions shall be reported to the BAS.
- H. The refrigerant monitor shall be powered by an Emergency Power Circuit.

2.20 ROOM STATIC PRESSURE MONITOR AND PROBE

- A. Provide flush or wall mounted room pressure monitor with room and reference pressure fittings to a remote pressure transducer with a 1 percent accuracy, 4-20ma analog output with a resolution of 0.001 inch w.c., red and green LEDs to alert operating personnel to the room pressure status and audible alarm horn with local silence button. Locate as shown on contract drawings. Alternates may include more descriptive display screens.
- B. Provide factory calibration to NIST procedures with documentation.

2.21 CONTROL TRANSFORMERS

- A. UL-listed, class II with 120 VAC primary and 24 VAC secondary. Provide with integral manual reset circuit breaker.

2.22 OXYGEN DEPRIVATION, CARBON DIOXIDE, CARBON MONOXIDE OR NITROGEN DIOXIDE (DIESEL) MONITOR:

- A. General: Wall mounted, polycarbonate enclosure, UL Classified and CSA certified with multi-channel microprocessor-based controller gas monitoring system.
- B. Provide visual three-digit display of concentration on front of sensor panel. Alarm shall be silenced by pressing button on wall in vicinity of room. Provide a single calibration kit.
- C. Performance:
 - 1. Sensor Power 17 – 27 Vac, 20 – 38Vdc.
 - 2. Relay Output 1 DPDT relay, 5A @ 250Vac; 5A @ 30Vdc.
 - 3. Accuracy: +/-3% of full scale.
 - 4. Range: as required for application. Review with vendor (By Volume).



5. Sensor Life Two Year minimum.

D. Communications: RS485 Modbus; BACnet MS-TP master.

2.23 HIGH STATIC PRESSURE SWITCH:

- A. Diaphragm operated to actuate a single pole, double throw, snap action switch.
- B. Motion of diaphragm shall be restrained by a calibrated spring that can be adjusted to set exact pressure differential at which electrical switch will be actuated.
- C. Set Point Adjustment: Screw type with set point indicated on a visual scale.
- D. Select pressure switch range for specific fan application.
- E. Provide switch with a manual reset function.

2.24 UNINTERRUPTIBLE POWER SOURCE

- A. Manufacturer: Eaton 3S 550. Substitutions shall be allowed per Division 01.
- B. Provide at each stand-alone controller where indicated by control drawings.
- C. Provide protection from power surges, spikes, blackouts and brownouts.
- D. Provide immunity from electrical sags, surges, transients, noise, and outages.
- E. Performance:
 - 1. Output Voltage Regulation: Plus or minus 10 percent.
 - 2. Output Frequency Regulation: 0.1 Hz.
 - 3. Output Overload Capability: 125 percent for 1 second causes shutdown without hardware damage.
 - 4. Transient Suppression: Tested to IEEE 587.
 - 5. Battery Reserve: 15 minute typical at full load for controllers; 10-15 minutes with a typical PC load for Supervisory Stations.
 - 6. EMI/RFI: Complies with FCC Part 15J, Class A.
- F. Electrical:
 - 1. Input Voltage: Single Phase, two-wire plus ground.
 - 2. Input Frequency: 50/60 Hz auto select.
 - 3. For Supervisory Stations, provide UPS with quantity of outlets for CPU, Monitor, and printers.
- G. Environmental:
 - 1. Operating Temperature: 32 to 95 degrees F
 - 2. Relative Humidity: 0 to 90 percent non-condensing.
- H. Battery: Internal, sealed, captive electrolyte, non-corrosive, no flammable gases.
- I. Provided contacts for Low Battery and Trouble conditions signal to BAS.
- J. Provide a manual bypass switch permitting scheduled maintenance or UPS



replacement without power disruption.

2.25 VICONICS ROOM CONTROLLER

- A. Manufacturer: Viconics Technologies, Inc.
- B. All provided Viconics devices must interface with the BAS through a BACnet/MSTP connection. The connection must allow read/write access to all sensor values and set points.
- C. Provide all hardware and software necessary to backup and restore all Viconic parameters.

EXECUTION

3.01 INSTALLATION OF CONTROL DEVICES:

- A. General: Install systems and materials in accordance with manufacturer's instructions, details shown on drawings, and all applicable codes defined in design documents. Locate sensors in positions that most accurately represent the sensed medium. Ensure that single point sensors are positioned in a well-mixed medium position. Ensure that flow sensors are located in areas with minimal turbulence. Ensure that temperature and humidity sensors are located in a position that is remote from humidifiers and sufficiently downstream to ensure full moisture absorption.
- B. Averaging Temperature Sensors: Provide one linear foot of averaging sensor per square foot of coil face installed in serpentine fashion across entire face of coil.
- C. Airflow Measuring Stations: The Contractor is to coordinate the installation with the relevant mechanical duct installer or unit manufacturer according to the AFMS manufacturer's recommendations in an unobstructed straight length of duct (except those installations specifically designed for installation in fan inlet). For installations in fan inlets, provide on both inlets of double inlet fans and provide inlet cone adapter as recommended by AFMS manufacturer.
- D. Current Switches for Motor Status Monitoring: Adjust so that setpoint is below minimum operating current and above motor no load current.
- E. Flow Switches: Where possible, install in a straight run of pipe at least 15 diameters in length to minimize false indications.
- F. Fluid Flow Sensors: The Contractor is to coordinate the installation with the relevant mechanical pipe subcontractor to install per manufacturer's recommendations in an unobstructed straight length of pipe.
- G. Low Temperature Detectors (Freezestats): Install LTDs in a serpentine fashion where shown on drawing. Provide one foot of element for each square foot of coil face area. Where coil face area exceeds required length of element, provide multiple devices, wired in parallel for normally open close on trip application. Adequately support with coil clips that will not conduct temperature from the mounting surface to the element.
- H. Phase-Voltage-Frequency Monitor: Contractor shall install with coordination



required by the BAS Contractor.

- I. Pipe Surface Mount Temperature Sensor: Install with thermally conductive paste at pipe contact point. Pipe insulation shall be replaced in kind and adequately joined to existing undisturbed insulation. Maintain vapor barrier and finish to match. These should be temporary applications only, until a well may be installed for proper inflow measurement of temperature.
- J. Refrigerant Monitors: Install them in accordance with the manufacturer's instructions. Place sensing tips in locations to maximize effectiveness. Hard wire interlocks the emergency ventilation and shutdown of combustion devices.
- K. Relative Humidity Sensors: Provide element guard as recommended by manufacturer for high velocity installations. For high limit sensors, position remote enough to allow full moisture absorption into the air stream before reaching the sensor.
- L. Space Temperature Sensors: Sensors shall be located:
 - 1. Mount non-adjustable sensors with centerline 60" above finished floor. Sensors with adjustable setpoints and/or override switches must be mounted 48" above the finished floor.
 - 2. Coordinate location of sensor with work of other trades so sensor does not conflict with or is obstructed by such items as blackboards, bleachers, bookcases, etc.
 - 3. Conceal all control wiring to sensors located in new-finished spaces; the use of wire-mold is prohibited unless specified.
 - 4. Thermostats located in Bathrooms, Locker Rooms, Common Rooms, Storerooms, and Corridors shall be flush mounted type.
- M. Supply Duct Pressure Transmitters:
 - 1. General: Install pressure tips with at least 4 'round equivalent' duct diameters of straight duct with no takeoffs upstream. Install pressure tips securely fastened with tip facing upstream in accordance with manufacturer's installation instructions. Locate the transmitter at an accessible location to facilitate calibration.
 - 2. VAV System 'Down-Duct' Transmitters: Locate pressure tips approximately 2/3 of the hydraulic distance to the most remote terminal in the air system. AE must approve the final location.
- N. Test Ports: Provide test ports in ductwork at each temperature and humidity sensor location to facilitate sensor calibration. Test ports shall be 3/4" diameter minimum and accessible via a 2" x 4" junction box with insulated cover. Provide a test port for all pressure points in pipe work.
- O. Valve Bypass for Differential Pressure Sensors: Provide a five-valve bypass kit for protection of DP sensors where the static pressure on the pipe can potentially over-pressure one port with the other at atmospheric pressure. Kit shall include high and low pressure isolation valves, high and low pressure vent valves (five valve kit) and a bypass valve contained in a NEMA-1 enclosure. Enclosure shall be mounted no higher than 6 feet AFF.

END OF SECTION



25 35 19 CONTROL VALVES

GENERAL

1.01 SECTION INCLUDES:

- A. Description of Work
- B. Control Valve Requirements

1.02 DESCRIPTION OF WORK:

- A. Furnish and Install DDC instrumentation and control devices required supporting specified building automation system functions as detailed herein and Section 25 35 00.

PRODUCTS

2.01 CONTROL VALVES

- A. General:
 - 1. Provide factory fabricated control valves of type, body material and pressure class indicated. Valves shall be two-way or three-way type for two-position or modulating service as scheduled, shown on drawings, or as specified in Sequence of Operations.
- B. Close-Off (differential) Pressure Rating: Valve actuator and trim shall be furnished to provide the following minimum close-off pressure ratings:
 - 1. Water Valves: Shutoff at 150% of total system (pump) head.
- C. Water Valves:
 - 1. Body and trim style and materials shall be per manufacturer's recommendations for design conditions and service shown.
 - 2. Sizing Criteria:
 - i. Two-position service: Full port line size.
 - ii. Two-way modulating service: Pressure drop across the valve in a wide-open position, with full flow through the valve, shall be equal to 50% of the available pressure differential between the mains, with a minimum of 4 psi.
 - iii. Three-way Modulating Service: Pressure drop across the valve in a wide-open position, with full flow through the valve, shall be equal to twice the pressure drop through the heat exchanger (load), with a 3-psi minimum. 3-way valves shall have linear flow characteristics.
 - iv. 1-1/2 inch valves and smaller shall have screwed ends. 2 inch and larger shall have flanged or welded ends.
 - 3. Construction Type:
Segmented or Characterized Ball Type:
 - 1) Body: Carbon Steel; Seat: Reinforced Teflon (PTFE); Ball: Stainless Steel; Stem: Stainless Steel



- 2) Port: Segmented design with equal-percentage characteristic
- 3) Cold Service Pressure: 200 psi WOG

Plug-Type Globe Pattern:

Body: Bronze, screwed, 250 psi max (1/2" to 2"); Cast Iron, flanged, 125 psi max (2-1/2" and larger)

Stem: Stainless Steel; Seat: Brass; Plug: Brass, Bronze, or Stainless Steel

Butterfly Type:

- 1) Body: Extended neck epoxy coated cast or ductile iron with full lug pattern; Seat: EPDM; Disc: Bronze or Stainless Steel, pinned or mechanically locked to shaft; Bearings: Bronze or Stainless Steel; Shaft: Stainless Steel
- 2) Cold Service Pressure: 175 psi
- 3) Close Off: Bubble-Tight shutoff to 150 psi

Ball Type:

- 1) Body: Brass or Bronze, threaded ends; Seat: Reinforced Teflon; Ball: Stainless Steel; Stem: Stainless Steel
 - 2) Port: Standard or 'V' style
 - 3) Cold Service Pressure: 600 psi WOG
4. Water valves shall fail as specified in the Control Sequences.
 5. Evaporative Cooler Drain and Fill Valves:
Valve normal position shall be as shown on the drawings.
 6. For systems containing fluids other than water, provide documentation that the valve components in contact with the fluid are compatible with it.

EXECUTION

3.01 GENERAL:

- A. Refer to Section 25 5500 for general requirements.

3.02 INSTALLATION OF CONTROL VALVES:

- A. Refer to Section 25 55 00 for general installation requirements for all mechanical, electrical and controls work.
- B. Control Valves: Install so that actuators, wiring, and tubing connections are accessible for maintenance. Where possible, install with valve stem axis vertical, with operator side up. Where vertical stem position is not possible, or would result in poor access, valves may be installed with stem horizontal. Do not install valves with stem below horizontal, or down. Always refer to manufacturer's recommended installation best practices prior to installation.

END OF SECTION



25 55 00 CONTROL OF HVAC

GENERAL

1.01 SECTION INCLUDES

- A. Related Documents
- B. Approved Control Systems
- C. Contractor Responsibilities
- D. Description of Work
- E. Procurement
- F. BAS Quality Assurance and Performance Parameters
- G. Definitions and Functional Intent
- H. Submittal and Record Document Requirements
- I. System Architecture
- J. Warranty, Storage and Material Handling
- K. Construction Coordination Requirements
- L. Field Workmanship and Quality Control
- M. Wiring and Electrical Requirements
- N. Control Panels/Quantity and Location
- O. Demolition and Reuse of Existing Materials and Equipment
- P. Sequence of Work for Existing Systems Conversions

1.02 DEFINITIONS

- A. Accuracy: Accuracy shall include combined effects of nonlinearity, non-repeatability and hysteresis. See other Division 25 Sections for details specific to devices and applications.
- B. Advanced Application Controller (AAC): A device with limited resources relative to the Building Controller (BC). It may support a level of programming and may also be intended for application specific applications.
- C. American University (AU): Owner of all facilities and systems.
- D. Application Protocol Data Unit (APDU): A unit of data specified in an application protocol consisting of application protocol control information and possible application user data (ISO 9545).
- E. Application Specific Controller (ASC): A device with limited resources relative to the Advanced Application Controller (AAC). It may support a level of programming and may also be intended for application-specific applications. .
- F. BAS Contractor: Contractor responsible for the installation, programming,



- commissioning, training, and warranty service of the new building automation system.
- G. Binding: In the general sense, binding refers to the associations or mappings of the sources network variable and their intended or required destinations.
 - H. Building Automation System (BAS): The entire integrated management and control system
 - I. Building Controller (BC): A fully programmable device capable of carrying out a number of tasks including control and monitoring via direct digital control (DDC) of specific systems, acting as a communications router between the LAN backbone and sub-LANs, and data storage for trend information, time schedules, and alarm data.
 - J. Change of Value (COV): An event that occurs when a measured or calculated analog value changes by a predefined amount (ASHRAE/ANSI 135).
 - K. Client: A device that is the requestor of services from a server. A client device makes requests of and receives responses from a server device.
 - L. Continuous Monitoring: A sampling and recording of a variable based on time or change of state (e.g. trending an analog value, monitoring a binary change of state).
 - M. Contractor: Within this specification, all references to “Contractor” shall mean the contractor that holds the construction contract that incorporates the BAS. This contractor would normally be called the General Contractor, or Construction Management contractor, but ultimately, it is the contractor that is responsible for and owns the construction contract.
 - N. Controller or Control Unit (CU): Intelligent stand-alone control panel. Controller is a generic reference and shall include BCs, AACs, and ASCs as appropriate.
 - O. Control Systems Server (CSS): This shall be a computer (or computers) that maintain the systems configuration and programming database. This may double as an operator workstation.
 - P. Direct Digital Control (DDC): Microprocessor-based control including Analog/Digital conversion and program logic.
 - Q. Ethernet: Reference to the campus Information Technology network, used for normal business-related e-mail and Internet communication. IEEE 802.3 based network connecting multiple facilities with a central data warehouse and server, accessible via standard web-browser or client installed software.
 - R. Functional Profile: A collection of variables required to define the key parameters for a standard application. As this applies to the HVAC industry, this would include applications like VAV terminal, fan coil units, and the like.
 - S. Gateway (GTWY): A device, which contains two or more dissimilar networks/protocols, permitting information exchange between them



(ASHRAE/ANSI 135).

- T. Handheld Device (HHD): Manufacturer's microprocessor based device for direct connection to a Controller.
- U. LAN Interface Device (LANID): Device or function used to facilitate communication and sharing of data throughout the BAS
- V. Local Area Network (LAN): General term for a network segment within the architecture. Various types and functions of LANs are defined herein.
- W. Local Supervisory LAN: Ethernet-based LAN connecting Primary Controller LANs with each other and OWSs and CSSs. See System Architecture below. This LAN can function as the Primary Controlling LAN.
- X. Master-Slave/Token Passing (MS/TP): Data link protocol as defined by the BACnet standard. (ASHRAE/ANSI 135).
- Y. MMBTU (IT) / hour: One million international British thermal units per hour for energy use calculations in this Section.
- Z. Open Database Connectivity (ODBC): An open standard application-programming interface (API) for accessing a database developed. ODBC compliant systems make it possible to access any data from any application, regardless of which database management system (DBMS) is handling the data.
- AA. Operator Interface (OI): A device used by the operator to manage the BAS including OWSs, POTs, and HHDs.
- AA. Operator Workstation (OWS): The user's interface with the BAS system. As the BAS network devices are stand-alone, the OWS is not required for communications to occur.
- BB. Point-to-Point (PTP): Serial communication as defined in the BACnet standard.
- CC. Portable Operators Terminal (POT): Laptop PC used both for direct connection to a controller and for remote dial up connection.
- DD. Primary Controlling LAN: High speed, peer-to-peer controller LAN connecting BCs and optionally AACs and ASCs. Refer to System Architecture below.
- EE. Router: A device that connects two or more networks at the network layer.
- FF. Secondary Controlling LAN: Subordinate LAN connecting AACs and ASCs to the Primary Controlling LAN. Refer to System Architecture below.
- GG. Server: A device that is a provider of services to a client. A client device makes requests of and receives responses from a server device.
- HH. SQL: Standardized Query Language, a standardized means for requesting information from a database.
- II. Smart Device (SD): A control I/O device such as a sensor or actuator that can directly communicate with the controller network to which it is connected. This differs from an ASC in that it typically deals only with one variable.

1.03 PROCUREMENT



- A. The following are approved control system suppliers, manufacturers, and product lines:
 - 1. Siemens Desigo
 - 2. ALC WebCTRL

1.04 RESPONSIBILITIES

- A. BAS Contractor shall coordinate, manage and comply with all contract requirements to furnish and install a direct digital control Building Automation System (BAS).
- B. All BAS related interconnecting cabling, wiring, conduit, and associated support structures that would normally be installed to support the conduit, cabling, wire and BAS Field Enclosures shall be installed by the BAS Contractor.
- C. The BAS Contractor shall be responsible for the installation of all devices that comprise the BAS system and all wiring terminations as required to complete the installation of the BAS system.
- D. The BAS Contractor shall provide all drawings and details, to properly wire and terminate the BAS.
- E. The BAS Contractor shall assist the Owner and Engineer as needed with LEED credit qualification including utility metering trends, IAQ, and outside air delivery monitoring.

1.05 DESCRIPTION OF WORK

- A. The new BAS shall utilize electronic sensing, microprocessor-based digital control, and electronic actuation of dampers and valves as referred to in the sequence of operations to perform control sequences and functions specified. Refer also to control drawings, sequences of operation, and point lists.
- B. The distributed digital control (DDC) and building automation system (BAS) defined in this specification shall interface with an Ethernet network. Contractor shall provide all specified objects and services and have them configured/mapped as applicable.
- C. All control work shall be installed by the BAS contractor, unless specified otherwise. Certain building systems including but not limited to, electrical equipment, plumbing equipment, security systems, mechanical equipment and special systems are equipped with manufacturer furnished controls that must be integrated into the BAS for monitoring and control. All labor, materials, equipment, software, and services necessary for the installation of a complete integrated system shall be provided with the exception as noted in this specification.
- D. The proposed system must be entirely compatible with the existing building BAS. This includes open source BACnet compliant controllers and devices. No system, even if supplied by the same manufacturer, may be installed as sole source if gateways or other means are required to interface with the existing system.



1.06 PERFORMANCE PARAMETERS:

- A. The communication speed between the controllers, LAN interface devices, and operator interface devices shall be sufficient to ensure fast system response time under any loading condition. In no case shall delay times between an event, request, or command initiation and its completion be greater than those listed herein. Contractor shall reconfigure LAN and programming as necessary to accomplish these performance requirements (see Integrated Automation Software for Control and Monitoring Networks Section for alarm definitions):
1. 5 seconds between a Level 1 (critical) alarm occurrence and enunciation at operator workstation.
 2. 10 seconds between a Level 2 alarm occurrence and enunciation at operator workstation.
 3. 20 seconds between and a Level 3-5 alarm occurrence and enunciation at operator workstation.
 4. 3 seconds between an operator command via an operator interface to change a setpoint and the subsequent change in the controller.
 5. 3 seconds between an operator command via an operator interface to start/stop a device and the subsequent command to be received at the controller.
 6. 10 seconds between a change of value or state of an input and it being updated on an operator interface.
 7. 10 seconds between an operator selection of a graphic and it completely painting the screen and updating at least 10 points.
 8. 2 seconds for any point being used across the LAN for control between 2 Field Panels at any level of the architecture.
 9. Programmable Controllers: Programmable controllers shall be able to completely execute DDC PID control loops at a frequency adjustable down to once per second. Select execution times consistent with the mechanical process under control.
 10. Multiple Alarm Annunciations: Each workstation on the network shall receive alarms within 5 sec of other workstations.
 11. Reporting Accuracy: System shall report values with minimum end-to-end accuracy listed in Table 1.
 12. Control Stability and Accuracy: Control loops shall maintain measured variable at setpoint within tolerances listed in Table 2.



Table 1
Reporting Accuracy

Measured Variable	Reported Accuracy
Space Temperature	±0.5°C (±1°F)
Ducted Air	±0.5°C (±1°F)
Outside Air	±1.0°C (±2°F)
Dew Point	±1.5°C (±3°F)
Water Temperature	±0.5°C (±1°F)
Delta-T	±0.15°C (±0.25°F)
Relative Humidity	±5% RH
Water Flow	±2% of full scale
Airflow (terminal)	±10% of full scale (see Note 1)
Airflow (measuring stations)	±5% of full scale
Airflow (pressurized spaces)	±3% of full scale
Air Pressure (ducts)	±25 Pa (±0.1 in. w.g.)
Air Pressure (space)	±3 Pa (±0.01 in. w.g.)
Water Pressure	±2% of full scale (see Note 2)
Electrical (A, V, W, Power Factor)	±1% of reading (see Note 3)
Carbon Monoxide (CO)	±5% of reading
Carbon Dioxide (CO ₂)	±50 ppm

Note 1: Accuracy applies to 10% - 100% of scale

Note 2: For both absolute and differential pressure

Note 3: Not including utility-supplied meters



Table 2
Control Stability and Accuracy

Controlled Variable	Control Accuracy	Range of Medium
Air Pressure	±50 Pa (±0.2 in. w.g.)	50 Pa -1.5 kPa (0.2-6 in. w.g.)
	±0.25% of Full Scale (Devices for Setpoint Control BSL and LAB)	±63 Pa around setpoint (±0.25 in. w.g.)
	±50 Pa (±0.2 in. w.g.)	-1.5 kPa - -50 Pa (-6.0 to -0.2 in. w.g.)
Airflow	±10% of full scale	
Space Temperature	±1.0°C (±2.0°F)	
Duct Temperature	±1.5°C (±2.0°F)	
Humidity	±5% RH(Office) ±2% RH(Lab, BSL)	
Fluid Pressure	±10 kPa (±1.5 psi)	MPa (1-150 psi)
	±250 Pa (±1.0 in. w.g.)	0-12.5 kPa (0-50 in. w.g.) differential

1.10 SUBMITTALS

- A. Design engineer shall concurrently review all submittals along with the Owner's Engineering/IT/Facilities Departments and incorporate all comments into a final review document. All submittals shall comply with all Cx requirements.
- B. Electronic Submittals: Control submittals and O&M information shall be provided electronically in Adobe PDF format. Control drawings shall be electronically provided in Adobe PDF in a size no less than 11"x17". Documents will be developed in a preferred format or converted from their native electronic format directly to a preferred format. Any documents scanned as images must be converted to a searchable text format using OCR (Optical Character Recognition) and reduced in size prior to submission. O&M manual shall include electronic versions of the project Mechanical and Electrical design drawings.
- C. Product Data: Submit manufacturer's technical product data for each control device, panel, and accessory furnished, indicating dimensions, capacities, performance and electrical characteristics including compliance with grounding and power conditioning requirements, and material finishes. Also include installation and start-up instructions.
- D. Shop Drawings: Submit shop drawings for each control system, including a complete drawing for each air handling unit, system, pump, device, etc. with all point descriptors, addresses and point names indicated. Each shop drawing shall be provided in PDF & AutoCAD format and contain:



1. System Architecture, System Layout, Risers:
 - a) One-line diagram indicating schematic locations of all control units, workstations, LAN interface devices, gateways, etc. Indicate network number, device ID, drawing reference number, and controller type for each control unit. All optical isolators, repeaters, end-of-line resistors, junctions, ground locations etc. shall be located on the diagram. Indicate relevant communication protocol on each network segment.
 - b) Indicate device instance and MAC address for each CU. Indicate media, protocol, and type of each LAN.
 - c) Provide floor plans locating all control units, LAN interface devices, gateways, etc. Include all WAN and LAN communication wiring routing, power wiring, power originating sources, and low voltage power wiring. Wiring routing as-built conditions shall be maintained accurately throughout the construction period and the drawing shall be updated to accurately reflect accurate, actual installed conditions.
 - d) Indicate network number, device ID, address, MAC address, drawing reference number, and controller type for each control unit. Indicate media, protocol, and type of each LAN. All optical isolators, repeaters, end-of-line resistors, junctions, ground locations etc. shall be located on the floor plans.
 - e) For renovation projects, the system diagram should clearly show all new and modified connections to existing networks and controllers.
2. PI&D Schematic flow diagram of each air and water system showing fans, coils, dampers, valves, pumps, heat exchange equipment and control devices. Include narrative description of sequence of operation, as it will be applied by the proposed control system (providing verbatim copy of contract documents is not acceptable). Indicate which items will be installed by others. Where applicable, provide a diagram for factory-controlled equipment detailing the BAS interface.
3. All physical points on the schematic flow diagram shall be indicated with names, descriptors, and point addresses identified as listed in the point summary table.

With each schematic, provide a point summary table listing building number and abbreviation, system type, equipment type, full point name, point description, Ethernet backbone network number, network number, device ID, object ID (object type, instance number).
5. Label each control device with set point and range of adjustable control.
6. Label each controller input and output with the appropriate range.
7. Label each control device with the relevant detail drawing number.
8. Provide a Bill of Materials with each schematic. Indicate device identification to match schematic and actual field labeling, quantity, actual product ordering number, manufacturer, description, size, voltage range, pressure range, temperature range, etc. as applicable.



9. Provide a Control Valve Schedule listing valve and actuator information including: size, C_v , design flow, design pressure drop, manufacturer, model number, close off rating, control signal, line size, line pressure, ANSI class rating, tag number, system service, valve type, material construction of body, stem, disc, etc. Indicate normal positions of automatic return valves.
 10. Provide a Control Damper Schedule listing damper and actuator information including: size, material, blade arrangement, manufacturer, model number, control signal, close off rating, etc. Indicate normal positions of automatic return dampers.
 11. Provide an Air Flow Monitoring Station Schedule listing the following information: size, material, manufacturer, model number, control signal, CFM, velocity, etc.
 12. Provide a Metering Device Schedule listing the following information: Flow range, fluid type, mechanical input type (magnetic, wheel, ultrasonic), Manufacturer, Model, Purpose, Location.
 13. Indicate all required electrical wiring. Electrical wiring diagrams shall include both ladder logic type diagram for motor starter, control, and safety circuits and detailed digital interface panel point termination diagrams with all wire numbers and terminal block numbers identified. Provide panel termination drawings on separate drawings. Clearly differentiate between portions of wiring which are existing, factory- installed and portions to be field-installed.
 14. Provide details of control panels, including controls, instruments, and labeling shown in plan or elevation indicating the installed locations and allocated service clearances. Provide panel layout drawing including power supply, control unit(s) and wiring terminals.
 15. Sheets shall be consecutively numbered.
 16. Each sheet shall have a title indicating the type of information included and the system controlled.
 17. A Table of Contents shall list sheet titles and sheet numbers followed by a symbol legend and list of abbreviations.
 18. BACnet Protocol Implementation Conformance Statement (PICS) for each submitted type of controller and operator interface.
- E. Control Logic Documentation
1. Submit control logic program listings to document the control software of all control units.
Include written description of each control sequence.
- F. Operation and Maintenance Materials:
1. Documents shall be provided electronically as described for electronic submittals.
 2. Submit maintenance instructions and spare parts lists for each type of control device, control unit, and accessory.



3. Include all submittals (product data, shop drawings, control logic documentation, hardware manuals, software manuals, installation guides or manuals, maintenance instructions and spare parts lists) in maintenance manual. Only include sections for equipment and software used on this project. Do not provide entire catalog of product data with extraneous information, cross out or draw a single line thru non-related data.
 4. Submit BAS User's Guides (Operating Manuals) for each controller type and for all workstation hardware and software and workstation peripherals.
 5. Submit BAS advanced Programming Manuals for each controller type and for all workstation software.
- G. Schedule
1. Schedule of work provided within two weeks of contract award, indicating.
 - a) Intended sequence of work items
 - b) Start date of each work item
 - c) Duration of each work item
 - d) Planned delivery dates for ordered material and equipment and expected lead times
 - e) Milestones indicating possible restraints on work by other trades or situations
 2. Monthly written status reports indicating work completed and revisions to expected delivery dates. Include updated schedule of work.
- H. Panel Control Drawings
- Provide laminated control drawings within each control panel for the CUs and devices controlled from that panel. System control schematics shall be mounted adjacent to key pieces of equipment for that system. Panel termination drawings shall be mounted in or adjacent to respective panels.
- I. System Conversion Planning
1. Submit schedule of work with respect to equipment outages and/or occupancy/work schedules.
 2. Provide details of control panels, including controls and instruments impacted. Provide scale panel layout drawing including power supply, control unit(s) and wiring terminals impacted.
 3. Provide details of additional power source connections required beyond those provided in the existing system.
- J. Controls contractor shall provide Owner with all product line technical manuals and technical bulletins, to include new and upgraded products, by the same distribution channel as to dealers or branches throughout the warranty period of the project.



- K. Manufacturers Certificates: For all listed and/or labeled products, provide a certificate of conformance.
- L. Product Warranty Certificates: Coordinate and submit manufacturers product warranty certificates covering the hardware provided once approved by the Owner. List the local offices and the representatives to perform routine and emergency maintenance on system components.
- M. Re-Submittals: Include cover letter that specifically responds to all previous submittal comments and explains how they are addressed in the current re-submittal.

1.07 PROJECT RECORD DOCUMENTS

- A. Documentation shall be provided electronically
- B. As-Built copies of product data and control shop drawings updated to reflect the final installed condition.
- C. As-Built copies of approved control logic programming and database uploaded and stored on the project BAS server. Accurately record actual setpoints and settings of controls, final sequence of operation, including changes to programs made after submission and approval of shop drawings and including changes to programs made during specified testing.
- D. As-Built copies of approved project specific graphic software stored on the Owner's BAS server.
- E. As-Built copies shall include individual floor plans with controller locations with all interconnecting wiring routing including space sensors, LAN wiring, power wiring, low voltage power wiring.
- F. As-Built copies shall include the final riser diagram showing the location of all controllers.
- G. As-Built copies shall include ALL control drawings revision history to reflect the As-Built date. No drawing, Document nor database shall be provided without the final As-Built revision date and comment attached.
- H. All As-Built documents shall be provided electronically and copied to the BAS CSS. Links to this documentation shall be provided on each equipment graphic for access to the as-built shop drawings, point lists, and sequences of operation.
- I. Confirm AU BAS Supervisor can access all record documentation once uploaded to CSS.

1.08 SYSTEM ARCHITECTURE

- A. The system provided shall incorporate hardware resources sufficient to meet the functional requirements of this project. The Contractor shall include all items not specifically itemized in these Specifications that are necessary to implement, maintain, and operate the system in compliance with the functional intent of these contract documents.
- B. The system shall be configured as a distributed processing network(s) capable of expansion.



- C. The system architecture shall consist of an Ethernet-based, wide area network (WAN), a single Local Area Network (LAN) or multi-levelled LANs that support BCs, AACs, ASCs, Operator Workstations (OWS), Smart Devices (SD), and Remote Communication Devices (RCDs) as applicable. The BAS network shall be able to seamlessly communicate using the standard protocols, MODBUS and BACnet, at all network levels. The following is a functional description of the BAS structure.
1. WAN: Internet-based network connecting multiple facilities with a central data warehouse and server, accessible via standard web-browser. This is an existing infrastructure and the contractor is not required to configure any components of this WAN. Refer to Section 25 11 16 for requirements.
 2. Local Supervisory LAN: The Local Supervisory LAN is an extension of the WAN. Contractor will be provided specific ports dedicated for control module/interface device connectivity. Contractor may not extend this network without prior approval from the Owner. Power-line carrier communication shall not be acceptable for communications.
 - a. The Contractor is responsible for the installation of a temporary Ethernet network that will serve the purpose of the Local Supervisory LAN until such time as the permanent Local Supervisory LAN is available. Should the temporary network be required, the BAS Contractor is responsible for the coordination and implementation of the Local Supervisory LAN to conform to the eventual permanent LAN's settings and addresses for the BAS.
 3. Primary Controller LAN ('Primary LAN'): High-speed, peer-to-peer communicating LAN used to connect Building Controllers (BCs) and communicate control information.
 4. Secondary Controller LAN ('Secondary LAN'): Network used to connect AACs, ASCs or SDs. These can be BACnet MS/TP or MODBUS, in addition to those allowed for Primary Controller LANs. Network speed versus the number of controllers on the LAN shall be dictated by the response time and trending requirements (see the Integrated Automation Remote Control Panels Section).
- D. Dynamic Data Access: Any data throughout any level of the network shall be available to and accessible by all other devices, Controllers and OWS, whether directly connected or connected remotely.
- E. Communication Interruptions: Interruptions or fault at any point on any Primary Controller LAN shall not interrupt communications between other nodes on the network. If a LAN is severed, separate networks shall be formed and communications within each network shall continue uninterrupted.
- F. Communication Devices: All line drivers, signal boosters, and signal conditioners etc. shall be provided as necessary for proper data communication (see also Network Bandwidth Management).
- G. Control Systems Server (CSS): The CSS is a virtual machine that maintains the systems configuration, programming database, and historical trend data. The BAS software shall be platform independent and



capable of residing on Owner's specific operating system with virtualization software. It shall hold backup files of information downloaded into the individual controllers and as such support uploading and downloading that information directly to/from the controllers. It shall also act as a control information server to non-control system based programs. It shall allow secure multiple-user access to the control information. Refer to Section 25 1113 – Integrated Automation Network Servers for its requirements.

1. Operator Interfaces shall provide for overall system supervision, graphical user interface, management report generation, alarm annunciation, and remote monitoring. Refer to Section 25 1113 – Integrated Automation Network Servers.
 2. During construction and prior to acceptance by the Owner new BAS projects will reside on their respective QA (Quality Assurance) server. This server operates separately from the primary CSS to prevent construction phase work from impacting existing systems. The CSS QA will be configured to match the primary CSS capability and allow testing of all CSS functions including historical trending and alarm reporting.
- H. Field Panel Independence: The BCs, AACs, ASCs, and SDs shall monitor, control, and provide the field interface for all points specified. Each BC, AAC, or ASC shall be capable of performing all specified energy management functions, and all DDC functions, independent of other BCs, AACs, or ASCs and operator interface devices as more fully specified in Section 25 1413 - Integrated Automation Remote Control Panels.

1.09 WARRANTY MAINTENANCE

- A. All references to the term 'Contractor' shall mean both the BAS Contractor and contractors providing installation services.
- B. The contractor shall warrant all BAS products and labor for a period of two years after substantial completion.
- C. The Owner reserves the right to make changes to the BAS during the warranty period. Such changes do not constitute a waiver of warranty. The Contractor shall warrant parts and installation work regardless of any such changes made by the owner.
- D. Maintenance Services: During the warranty period, the Contractor shall provide maintenance services for software and hardware components as specified below, at no additional cost. The AU BAS department will be the Owner's authorized representative for all service requests:
 1. Maintenance services shall be provided for all devices and hardware supplied by the BAS Contractor. Service all equipment per the manufacturer's recommendations. All devices shall be calibrated within the last month of the warranty period. An update to the points

Information Block detail of the points definition in the CSS shall be added indicating the date of calibration and initials of the technician performing calibration.

2. Emergency Service: Any malfunction, failure, or defect in any hardware



component or failure of any control programming that would result in customer impact, property damage or loss of comfort control shall be corrected and repaired following notification by the Owner to the Contractor.

- a. If the malfunction, failure, or defect is not corrected through remote communication, at least one (1) hardware and software technician, trained in the system to be serviced, shall be dispatched to the Owner's site.
3. Normal Service: Any malfunction, failure, or defect in any hardware component or failure of any control programming that would not result in property damage or loss of comfort control shall be corrected and repaired following notification by the Owner to the Contractor.
 - a. If the malfunction, failure, or defect is not corrected through remote communication, at least one (1) hardware and software technician, trained in the system to be serviced, shall be dispatched to the Owner's site on the next available business day.
4. Technical Support: Contractor shall provide remote technical support throughout the warranty period.
5. Preventive Maintenance: Preventive maintenance shall be provided throughout the warranty period in accordance with the hardware component manufacturer's requirements.
6. Product Updates: Provide updates to operator workstation or web server software, project-specific software, graphic software, database software, and firmware that resolve Contractor-identified software deficiencies at no charge during warranty period. Do not install updates or upgrades without Owner's written authorization.

1.10 DELIVERY, STORAGE, AND HANDLING

- A. Provide factory-shipping cartons for each piece of equipment and control device. Maintain cartons during shipping, storage and handling as required to prevent equipment damage, and to eliminate dirt and moisture from equipment. Store equipment and materials indoors, within manufacturer's specified environmental conditions and protect from construction work, weather and theft.

1.11 LISTING AND LABELING

- A. The BAS and components shall be listed by Underwriters Laboratories (UL 916) as an Energy Management System.
- B. Portions of the BAS utilized for fire/smoke management, stairwell pressurization controls and monitoring shall be listed by Underwriters Laboratories (UUKL 864).

1.12 OWNERSHIP OF PROPRIETARY MATERIAL

- A. Project specific software and documentation shall become the Owner's property. This includes, and is not limited to:
 1. System database structure project files.



2. System custom code project files.
3. System graphic project files.
4. Record Drawings of all file types, including the Design File Format of all project drawings.
5. Documentation

PRODUCTS

2.01 MATERIALS AND EQUIPMENT

- A. Materials shall be new, the best of their respective kinds without imperfections or blemishes and shall not be damaged in any way. Used equipment shall not be used in any way for the permanent installation except where drawings or specifications specifically allow existing materials to remain in place or be reinstalled.
- B. Do not use this installation as a product test site unless explicitly approved in writing by Owner. Spare parts shall be available for at least five years after completion of this contract.
- C. No product lines or materials should be used that are listed on an end-of-life or sunset schedule from the manufacturer. Product documentation of product line and/or materials production status to the Owner if requested.

2.02 UNIFORMITY

- A. To the extent practical, all equipment of the same type serving the same function shall be identical and from the same OEM manufacturer.

2.03 PRODUCTS NOT FURNISHED NOR INSTALLED BUT INTEGRATED WITH WORK OF THIS SECTION

- A. Coordination Meetings: The Contractor shall coordinate meetings between the BAS Contractor and the Installers(s) furnishing each of the following products to coordinate the details of the interface between these products and the DDC network. The Owner or his representative shall be present at every coordination meeting. Submittals for these products shall not be approved prior to the completion of this meeting. Any issues identified during these meetings must also be resolved satisfactorily and with agreement between the BAS Contractor and the Installer(s) prior to the submittal being approved. Each Installer shall provide the Owner and BAS Contractor and all other Installers with the details of the proposed interface including the following.
 1. BACnet PICS
 2. Point List
 3. Wiring Requirements
 4. Communication Specifications for speed, type etc.
 5. Required Network Accessories
 6. (3) Past Examples of Integration to the proposed BAS at the Field Panel (BC) communication Level of the Architecture.



7. Network Identifiers
 - B. Communications with Third Party or Factory Controlled Equipment:
 1. Any additional integral control systems included with the products integrated with the work of this section shall be furnished with an interface for integration into the Direct Digital Control system described in this section.
 2. The integration shall be of the following methods determined during the coordination meetings:
 - a) Hardwired connection such as relay, 0-10VDC, or 4-20mA
 - b) BACnet/IP network connection. (Only for panel level)
 - c) MODBUS network connection. (Only for utility)
 - d) BACnet MS/TP network connection
 - C. Decentralized HVAC Equipment
 1. Unit Ventilators, Unit Heaters, Fan Coils, etc.: Unit ventilators, unit heaters, fan coils, cabinet heaters, convective or fin tube heaters, zone reheat, and similar terminal units. These units shall be furnished and configured to accept control inputs from an external building automation system controller.
 - D. Variable Frequency Drives
 1. Variable Frequency Drives: The variable frequency drive (VFD) vendor shall furnish all VFDs with an interface to the BAS. The specified interface points shall be the minimum acceptable interface to the VFD. The connection to these points shall be of the following methods determined during the coordination meetings:
 - a) Hardwired connection such as relay, 0-10VDC, or 4-20mA
 - b) BACnet/IP network connection
 - c) BACnet MS/TP network connection

EXECUTION

3.01 INSPECTION

- A. Inspect site to verify that equipment can be installed as shown. Report discrepancies, conflicts, or omissions to Engineer for resolution before starting rough-in work.

3.02 CONSTRUCTION COORDINATION

- A. Test and Balance:
 1. BAS Contractor Support:
 - a) The BAS Contractor shall provide the Test and Balance Contractor with access to the control system for testing and balancing.
 - b) The BAS Contractor shall train the Test and Balance Contractor as necessary.
- B. Electrical Coordination:
 1. The BAS Contractor shall coordinate all facets of the BAS installation.



2. The BAS Contractor shall validate the accuracy, fit and finish of all installed BAS Electrical work results in comparison to the BAS Design documents, during the project.
- C. Third Party Coordination:
1. The BAS Contractor shall be the systems integrator for all third-party control systems that must interface with the BAS.
 2. Each supplier shall comply with the communication media, software and equipment as specified in Section 25 5500.
 3. Each supplier of a control product shall configure, program, start up, and test that product to meet the sequences of operation regardless of where within the contract documents those products are described.
 4. Coordinate and resolve incompatibility issues that arise between control products provided under this section and those provided under other sections or divisions of this specification.
 5. BAS Contractor shall be responsible for integration of control products provided by multiple suppliers regardless of where integration is described within the contract documents.

3.03 WIRING

- A. Control and interlock wiring and installation shall comply with national and local electrical codes, Division 26, and manufacturer's recommendations.
- B. NEC Class 2 (current-limited) wires not in raceway but in concealed and accessible locations such as return air plenums shall be UL listed for the intended application.
- C. Install wiring in raceways subject to mechanical damage and at levels below 3 m (10ft) in mechanical, electrical, or service rooms.
- D. Use structural members to support or anchor plenum cables without raceway. Do not use ductwork, electrical raceways, piping, or ceiling suspension systems to support or anchor cables.
- E. Raceways and pull boxes shall not be hung on or attached to ductwork, electrical raceways, piping, or ceiling suspension systems.
- F. Include one pull string in each raceway 1.8 cm (3/4 in.) or larger.
- G. Locate control and status relays in designated enclosures only. Do not install control and status relays in packaged equipment control panel enclosures containing Class 1 starters.
- H. Conceal raceways except within mechanical, electrical, or service rooms.
- I. Flexible metal raceways and liquid-tight flexible metal raceways shall not exceed 1 m (3 ft) in length and shall be supported at each end. Do not use flexible metal raceway less than 1/2 in. electrical trade size. Use liquid-tight flexible metal raceways in areas exposed to moisture including chiller and boiler rooms.
- J. Install raceway rigidly, support adequately, ream at both ends, and leave clean and free of obstructions.



- K. Make terminations in boxes with fittings. Do not make terminations in boxes with bushings.
- L. Do not make splices in plenum wire.
- M. All splices made shall be placed within a box or enclosure and labeled as a BAS splice on the cover.
- N. All raceways will be labeled as BAS.

3.04 COMMUNICATION WIRING

- A. Install communication wiring in separate raceways and enclosures from other wiring.
- B. During installation do not exceed maximum cable pulling, tension, or bend radius specified by the cable manufacturer.
- C. Label communication wiring to indicate origination and destination.
- D. BACnet MS/TP communications wiring shall be installed in accordance with ASHRAE/ANSI Standard 135. This includes but is not limited to:
 - 1. The network shall use shielded, twisted-pair cable with characteristic impedance between 100 and 120 ohms. Distributed capacitance between conductors shall be less than 100 pF per meter (30 pF per foot).
 - 2. The maximum length of an MS/TP segment is 1200 meters (4000 ft) with AWG 18 cable. The use of greater distances and/or different wire gauges shall comply with the electrical specifications of EIA-485.
 - 3. The maximum number of nodes per segment shall be 32, as specified in the EIA 485 standard.
 - 4. An MS/TP EIA-485 network shall have no T connections.
- E. AU will provide all BC's and Third Party Integration Devices (e.g. All BACnet/IP devices) with an Ethernet connection point.

3.05 WARNING LABELS

- A. Affix permanent warning labels to equipment that can be automatically started by the control system.
 - 1. Labels shall use white lettering (12-point type or larger) on a red background.
 - 2. Warning labels shall read as follows:

CAUTION

This equipment is operating under automatic control and may start or stop at any time without warning.

Switch disconnect to "Off" position before servicing.

- B. Affix permanent warning labels to motor starters and control panels that



- are connected to multiple power sources utilizing separate disconnects.
1. Labels shall use white lettering (12-point type or larger) on a red background.
 2. Warning labels shall read as follows:

CAUTION
This equipment is fed from more than one power source with separate disconnects.
Disconnect all power sources before servicing.

3.06 IDENTIFICATION OF HARWARE AND WIRING

- A. Label wiring and cabling, with control system identification information, at each end within 5 cm (2 in.) of termination.
- B. Permanently label or code each point of field terminal strips to show instrument or item served.
- C. Label control panels with minimum 1 cm (½ in.) letters on laminated plastic nameplates.
- D. Label each control component with a permanent label. Label plug-in components such as label remains stationary during component replacement.
- E. Label room sensors related to terminal boxes or valves with nameplates. Ensure the nameplate is aesthetically pleasing and unobtrusive to the room sensors functionality or design.
- F. Manufacturers' nameplates and UL or CSA labels shall be visible and legible after equipment is installed.
- G. Label identifiers shall match record documents.

3.10 CONTROL PANELS, CONTROLLER QUANTITY AND LOCATION

- A. Control panels shall consist of one or multiple controllers to meet the requirements of this specification. Control panels shall be wall mounted within mechanical equipment rooms. Electrical equipment rooms may be used with prior Owner approval. In no case shall panels, other than terminal unit controllers, be located above ceilings.
- B. Restrictions in applying controllers are specified in Section 25 14 13 - Integrated Automation Remote Control Panels. If the BAS contractor wishes to further distribute panels to other locations, the Contractor is responsible for extending power to that location also. Furthermore, the Contractor is responsible for ensuring adequate locations for the panels that do not interfere with other requirements of the project and maintain adequate clearance for maintenance access.



- C. It is the BAS Contractor's responsibility to provide enough controllers to adequately accomplish the sequence of operations and the required point lists plus an added 20% of each of the available point types, AI, AO, BI, BO. No controller installed shall exceed 80% of the point capacity of each of the four point types, AI, AO, BI, BO. This does not apply to those controllers on the Secondary Controller LAN.
- D. Point expansion modules shall be considered an extension of the controller they are connected to and as such are integral to that controller. Point expansion modules shall comply with the same installation rules as the controller they are connected to regardless of the actual LAN they are communicating upon.
- E. Controllers for terminal equipment:
 - 1. For equipment located in the conditioned space, controllers shall be mounted inside the unit enclosure. Where sufficient mounting space is not available inside the unit enclosure, a control panel shall be installed above the ceiling, inside the room, as close to the room space sensor as possible with the exception of spaces with impenetrable hard ceilings, in which case the controller shall be mounted above the ceiling in an adjacent hallway as close to the equipment served as possible. Coordinate with the AE and Owner to clarify acceptable mounting locations.
 - 2. For equipment located above drop ceilings, controllers shall be unit mounted within a plenum rated enclosure. Provide adhesive backed ceiling labels, affixed to ceiling grid below all ceiling concealed controllers, affix to ceiling panel access door for solid ceilings.

3.11 CONTROL POWER SOURCE AND SUPPLY

- A. Contractor shall extend all power source wiring required for operation of all equipment and devices included within the BAS.
- B. General requirements for obtaining power include the following:
 - 1. All control panels shall be served by dedicated power circuits. BC control panels served by stand-by power circuits shall additionally be provided with one of the following.
 - a) As Primary selection, a dedicated available UPS circuit from the buildings UPS system to meet the requirements for BC power failure operation in Section 25 1413 - Integrated Automation Remote Control Panels.
 - b) As Secondary selection, an external UPS power supply to meet the requirements for BC power failure operation in Section 25 14 13 - Integrated Automation Remote Control Panels. Control panel shall be labeled with electrical panel name & circuit number.
 - 2. Where a controller controls multiple systems with varying levels of power reliability (normal, stand-by, and/or interruptible), the controller shall be powered by the highest level of reliability taking into account the space restrictions mentioned above.



3. For all controlled equipment operating with an available stand-by generator the control panel must be powered from the same power source including the same automatic transfer switch for normal or stand-by power.
 4. Standalone Functionality: Refer to Section 25 14 13 - Integrated Automation Remote Control Panels.
 5. Obtain power from a source that feeds the equipment being controlled such that both the control component and the equipment are powered from the same MCC or panel. Where equipment is powered from a 460V source, obtain power from the electrically most proximate 120 VAC source fed from a common origin.
 6. Where control equipment is located inside a new equipment enclosure, coordinate with the equipment manufacturer and feed the control with the same source as the equipment. If the equipment's control transformer is large enough and of the correct voltage to supply the controls it may be used. If the equipment's control transformer is not large enough or of the correct voltage to supply the controls provide separate transformer.
- C. Power Supplies: Control transformers shall be UL listed. Furnish Class 2 current-limiting type or furnish over-current protection in primary and secondary circuits for Class 2 service in accordance with NEC requirements. Limit connected loads to 80% of rated capacity.

3.12 SURGE PROTECTION

- A. The Contractor shall furnish and install any power supply surge protection, filters, etc. as necessary for proper operation and protection of all BCs, AAC/ASCS operator interfaces, routers, gateways and other hardware and interface devices. All equipment shall be capable of handling voltage variations 10% above or below measured nominal value, with no effect on hardware, software, communications, and data storage. CUs and panels shall have suppressors to protect against lightning damage, induced voltage from other equipment, and RF interference as applicable.

3.13 DEMOLITION AND REUSE OF EXISTING MATERIALS AND EQUIPMENT

- A. Existing control modules that will be replaced as part of this project are to be turned over to AU BAS department. All other existing control devices and panels that will not be reused are to be removed from the site.
- B. Existing electrical service to control panels or devices that will not be reused must be properly terminated and secured per NEC requirements. Label wire with the panel and circuit breaker.
- C. Existing valves and dampers and their operators shall be reused, except where noted to be removed or provided as new. The contractor shall lubricate all damper linkages of dampers being controlled under this project.
- D. Other materials and equipment not specifically mentioned herein may be reused only if specifically allowed by indications on the drawings.
- E. Where existing wall mounted devices are removed in finished spaces,



comply with the requirements of Division 01.

- F. Removed materials and equipment shall be subject to the requirements of Division 01.
- G. For systems with existing workstation graphics, the existing graphic must be entirely removed from the system including all links and references and replaced with a new graphic meeting all requirements of these BAS Sections. If renovation is only partial, graphics for existing equipment to remain shall have links to changed or removed equipment updated.
- H. Existing system points shall be released. Partial system renovations shall not be split between old and new points. All points shall be created or recreated to meet the requirements of these BAS guidelines.

3.14 SEQUENCE OF WORK

- A. General: All work involving changeover of control functions from existing systems to the new BAS shall be performed in accordance with the following sequence to minimize the duration of equipment outages. The following descriptions are intended to indicate the sequence in which the work shall be performed, not to define fully the scope of the work.
- B. Install construction server, operator's terminal, peripherals, graphic software, and LAN prior to placing any equipment under the control of the new BAS.
- C. Work which requires shutting down a pump motor, fan motor, or chiller shall be considered a utility shutdown and shall be subject to the restrictions specified in Division 01.
- D. The following sequence applies to an individually controlled HVAC subsystem, such as an air handling unit. Only one such system shall be placed under manual control (as described below) at any given time.
 - 1. Install CUs adjacent to (or within) existing control panel. Programming shall be complete (except for loading and debugging) prior to installation. Install all field devices which do not require interruption of the existing system.
 - 2. Install all conduit and wiring which does not require interruption of the existing system.
 - 3. Remove existing controls including wiring and conduit (except materials to be reused in accordance with provisions specified elsewhere) which must be removed to facilitate installation of new BAS materials and equipment.
 - 4. Remove existing digital points. Install and calibrate the remainder of new BAS materials and equipment for this subsystem. Load CU software. Connect CU(s) to LAN.
 - 5. Perform all field testing and calibration that does not require connection of permanent outputs.
 - 6. Notify the contracting officer prior to this step. Place the system under the control of the new BAS equipment. Conclude field testing and submit field-testing report prior to placing the next subsystem under control.



7. Remove remaining existing materials and equipment (except materials to be reused in accordance with provisions specified elsewhere). All existing equipment for those subsystems that have not yet been converted shall remain intact, on-line, and fully functional.

3.15 BAS START UP, COMMISSIONING AND TRAINING

- A. Refer to Commissioning requirement guidelines.

3.16 SEQUENCE OF OPERATION

- A. Refer to Project Manual and Drawings for specific requirements.

END OF SECTION



25 55 00.13 CONTROL OF HVAC OBJECT NAMING CONVENTION

GENERAL

1.01 SECTION INCLUDES:

- A. Outline of the naming requirements for all BAS objects.

1.02 DEFINITIONS

- A. Object: Any named software or hardware component contained in the BAS.
- B. Object Descriptor: A 16-character free text attribute of a BAS object.

PRODUCTS

2.01 GENERAL:

- A. This object naming convention is to be applied to the project BAS and all integrated systems.
- B. Its design and modifications are wholly owned and approved by the Owner.
- C. The object naming convention applies to those objects with unique naming requirements within the BAS and any integrated system. The BAS contractor is always the systems integrator for third party control systems and as such owns the responsibility to ensure all objects conform to the naming convention prior to implementation.
- D. The naming of objects shall be consistent in the project documents, drawings, specifications, equipment labeling and graphics.
- E. Any variance as required to perform a particular function with any project application shall be reviewed and approved during that projects BAS review period.
- F. The BAS Contractor should submit periodic proposals for updates to include new system and device names as they may apply to any project.

2.02 OBJECT NAMING CONVENTION

A. General:

1. All objects shall conform to the following convention:
 - a) BUILDING.MACROLEVELSYSTEM.SUBSYSTEM.DEVICEDESC
RIPTOR
2. Each object name segment shall conform to the specific requirements defined herein.
3. The maximum character limit is 30 characters including all period (.) characters.
4. All object names shall be defined using all capital characters.
5. Only the period (.) character shall be used to delimit the segments of the object name.



2.03 CHANGE CONTROL

A. General:

1. When adding new list objects to this standard object naming convention the standard format in the list is:
 - a) OBJECTLISTITEMTEXT; Description
 - b) The semi-colon is not part of the object list item text.
2. Update the Revision Number at the beginning of this document by one for each new version of the document published to the Standards Library.
3. All modifications shall be placed in alphabetically correct order.

2.04 OBJECT NAME SEGMENTS

A. CAMPUS Segment:

1. The first segment of the object name.
2. This should not be more than 3 characters in length.

B. BUILDING Segment:

1. The second segment of the object name
2. This segment should not be more than 3 characters in length.
3. There shall be no period (.) character contained within the BUILDING segment.
4. This segment shall not be more than 5 characters in length, including a trailing period (.) character

C. MACROLEVELSYSTEM Segment:

1. The second segment of the object name
2. This segment is to describe the system containing the devices in the building.
3. This segment should not be more than 10 characters in length, including a trailing period (.) character providing consideration for overall object naming consistency.
4. Only MACROLEVELSYSTEMS contained in the MACROLEVELSYSTEMS List are permitted.
5. Any MACROLEVELSYSTEM can be succeeded by a numeral to indicate the sequence number for the system being given the name. The numeral is not delimited with a period (.).

D. SUBSYSTEM Segment:

1. The third segment of the object name
2. This segment is to describe the subsystems within the MACROLEVELSYSTEM segment in the building.
3. This segment should not be more than 8 characters in length, including a trailing period (.) character providing consideration for overall object naming consistency.
4. Only SUBSYSTEMS contained in the SUBSYSTEMS List are



permitted.

5. Any SUBSYSTEM can be succeeded by a numeral to indicate the sequence number for the system being given the name. The numeral is not delimited with a period (.).

E. DEVIDEDESCRIPTOR Segment:

1. The fourth and last segment of the object name
2. This segment is to describe the devices that are contained within a MACROLEVEL system in the building.
3. This segment should not be more than 8 characters in length providing consideration for overall object naming consistency.
4. Only DEVIDEDESCRIPTORS contained in the DEVIDEDESCRIPTORS List are permitted.
5. Any DEVIDEDESCRIPTOR can be succeeded by a numeral to indicate the sequence number for the system being given the name. The numeral is not delimited with a period (.).
6. Combining multiple DEVIDEDESCRIPTORS is permitted and shall not be delimited with a period (.) character.
7. When combining DEVIDEDESCRIPTORS it is expected the order of combining be dictated by the actual real English Language pronunciation of the device. Approve all device names during project application of the object naming convention and prior to any implementation.

2.05 CAMPUSNAME LIST

1. MC; Main Campus
2. WCL; Washington College of Law
3. EC; East Campus
4. CONN; 4401 Connecticut Ave.

2.06 BUILDING NAME LIST

3301 NEW MEXICO – 3301 New Mexico Avenue
3244 NEBRASKA AVE – 3244 Nebraska Avenue
4124 WARREN – 4124 Warren Street
4401 CONN – 4401 Connecticut Avenue
4545 42ND ST – 4545 42nd Street
45TH STREET – 45th Street Field
4621 ROCKWOOD – 4621 Rockwood Parkway
4625 ROCKWOOD – 4625 Rockwood Parkway
4629 ROCKWOOD – 4629 Rockwood Parkway
4633 ROCKWOOD – 4633 Rockwood Parkway



4810 ROCKWOOD – 4810 Rockwood Parkway
AH – Anderson Hall
ASB – Asbury Building
BCC – Media Production Center
BE – Beeghly Building
BL – Bender Library
BP – Butler Pavilion & Arcade
BT – Battelle-Tompkins
CA – Cassell Hall
CDC – Child Development Center
CH – Capital Hall
CK – Clark Hall
CN – Centennial Hall
CNST – Constitution Building
DBR – Duber Hall
DH – Dunblane House
DMTIB – Don Meyers Technology & Innovation Building
FDRL – Federal Hall
GB – Greenberg Theatre
GR – Gray Hall
HA – Hamilton Building
HF – Hockey Field
HH – Hughes Hall
HOS – Hall of Science
HU – Hurst Hall
ISB – School of International Services
KA – Katzen Arts Center
KH – Kerwin Hall
KB – Kogod School of Business
KR – Kreeger Hall
KS – Kay Spiritual Life Center
LFS – Jack Childs Language & Foreign Studies
LTH – Letts Hall
LH – Leonard Hall
MCB – McCabe Hall
MGC – Mary Graydon Center



MH – McDowell Hall
MK – McKinley
MPF – Multi-Purpose Field
MS – Washington College of Law Maintenance Shop
NH – Nebraska Hall
NMA – New Mexico Avenue
OS – Osborn Building
PB – President’s Office Building
PG – East Campus Parking Garage
PR – President’s Residence
RB – Rockwood Building
RH – Roper Hall
SC – Sports Center/Bender Arena
SCA – Sports Center Annex
SCLOT – Sports Center Parking Garage
SV – Spring Valley Building
TB – Transmitter Building
VM – Vehicle Maintenance Shop
WA – Watkins
WB – Warren Building
WCLPG – Washington College of Law Parking Garage
WIS – 4200 Wisconsin Avenue
WS – Wesley Seminary
YH – Yuma Hall

2.07 MACROLEVELNAME LIST

1. AHU#; Air Handling Units
2. ALN#; Automation Level Network
3. ATS#; Transfer Switch Systems
4. BLDG#; Building Systems
5. BLN#; Building Level Network
6. BLR#; Boiler Systems
7. CABHT; Cabinet Heaters
8. CAS#; Control Air Systems
9. CHLR#; Chiller Systems
10. CHP#; Chilled Water Pump
11. CHW#; Chilled Water Systems



12. CDP#; Condenser Water Pump
13. CDW#; Condenser Water Systems
14. CHM#; Chemical Treatment Systems
15. CPS#; Condensate Pump Systems
16. CRU#; Computer Room Unit
17. CT#; Cooling Tower System
18. CUH#; Cabinet Unit Heater
19. CW#; Condenser Water System
20. DCW#; Domestic Cold Water Systems
21. DHW#; Domestic Hot Water Systems
22. DWP#; Domestic Hot Water Pump
23. DX#; Direct Expansion Systems
24. EDH#; Electric Duct Heater
25. EF#; Exhaust Fan Systems
26. FAN#; Miscellaneous and General Purpose Fan Systems
27. FA#; Fire Alarm Systems
28. FCW#; Fan Coil Units with water coil
29. FCX#; Fan Coil Units with DX cooling
30. FLH#; Floor Heating System
31. FLN#; Floor Level Network
32. FTR#; Fin Tube Radiator
33. GEN#; Emergency Generator
34. HRC#; Heat Recovery Systems
35. HX#; Heat Exchanger System
36. HWP#; Hot Water Pump
37. HWS#; Hot Water Systems
38. KW#; Electric and Electric Metering Systems
39. LT#; Lighting
40. LP#; Lighting Panel
41. MAU#; Make-up Air Systems
42. MER#; Mechanical Equipment Room Systems
43. REF#; Relief Fan
44. RF#; Return Fan
45. RM#; Room Objects (Where # is the room number)
46. SC#; Security
47. SDP#; Sand Pump
48. SF#; Supply Fan



49. SPR#; Sprinkler Room
50. SUMP#; Sump Pump Systems
51. TNK#; Tank Systems
52. UH#; Unit Heaters
53. ZN#; Zone Systems

2.08 DEVICEDESRIPTOR LIST

A. General List

1. #; NUMBERS
2. AC; AIR COMPRESSOR
3. AFM#; AIR FLOW METERING DEVICES
4. ALM#; ALARM
5. ALN#; AUTOMATION LEVEL NETWORK
6. AVG#; AVERAGE
7. BLN#; BUILDING LEVEL NETWORK
8. BPV#; BYPASS VALVE
9. BSP#; BUILDING STATIC PRESSURE
10. BTU; BRITISH THERMAL UNIT
11. CAD#; COMBUSTION AIR DAMPER
12. CAV#; Constant Air Volume Terminal Box Control Systems
13. CCV#; COOLING VALVE
14. CDD#; COLDDECK DAMPER
15. CLS#; CLOSE
16. CMD#; COMMAND
17. CO#; CARBON MONOXIDE
18. CO2#; CARBON DIOXIDE
19. CUR#; AMPS
20. CW#; CONDENSER WATER DEVICES
21. DEW; DEWPOINT
22. DIV#; DIVERTING VALVE
23. DLK#; MAGNETIC DOOR LOCK
24. DP#; DIFFERENTIAL PRESSURE DEVICES
25. DPV#; DIFFERENTIAL PRESSURE VALVE
26. DSP#; DIFFERENTIAL PRESSURE SWITCH
27. DXS#; DX COOLING STAGE
28. EAD#; EXHAUST AIR DAMPER
29. ECON#; ECONOMIZER DEVICES
30. EMS#; EMERGENCY STOP SWITCH



31. ENB#; ENABLE/DISABLE COMMAND
32. ENTH#; ENTHALPY
33. EPO#; EMERGENCY POWER OFF BUTTON
34. ESW#; END SWITCH
35. FBD#; FACE BYPASS DAMPER
36. FC; FREE COOLING STATUS
37. FCV#; FLOW CONTROL VALVE
38. FF#; FLAME FAILURE
39. FIL#; FILTER STATUS (use State Text)
40. FIRE#; FIRE ALARM
41. FLN#; FLOOR LEVEL NETWORK
42. FLOW#; WATER OR AIR FLOW
43. GPM#; GALLONS PER MINUTE
44. H2#; HYDROGEN
45. HCV#; HEATING COIL VALVE
46. HDD#; HOTDECK DAMPER
47. HDP; HEAD PRESSURE
48. HLS#; HIGH/LOW SPEED COMMAND WITH FEEDBACK
49. HOA#; HAND-OFF-AUTO (Use state text)
50. HOUR#; TIME HOURS
51. HSP#; HIGH STATIC PRESSURE CUTOUT
52. HTS#; HEAT STAGE
53. HUV#; HUMIDITY VALVE
54. ILV#; INLET VANE
55. ISD#; ISOLATION DAMPER
56. ISV#; ISOLATION VALVE
57. L#; ADDITIONAL LEVEL INDICATOR
58. LGT#; LIGHTS
59. LL#; LEAD/LAG TOGGLE (Use enumerator)
60. LSP#; LOW STATIC PRESSURE CUTOUT
61. LTD#; LOW TEMPERATURE DETECTOR
62. LVL#; LEVEL SENSOR
63. LWT; LEAVING WATER TEMPERATURE
64. MAD#; MIXED AIR DAMPER
65. MAH#; MIXED AIR HUMIDITY
66. MAT; MIXED AIR TEMPERATURE
67. METR#; METERS (FLOW, KW)
68. MOIST#; MOISTURE SENSOR



69. MOT#; MOTION SENSOR
70. MXV#; MIXING VALVE
71. N2#; NITROGEN
72. NG#; NATURAL GAS
73. O2#; OXYGEN
74. OAD#; OUTSIDE AIR DAMPER
75. OAE#; OUTSIDE AIR ENTHALPY
76. OAH; OUTSIDE AIR HUMIDITY
77. OAT; OUTSIDE AIR TEMPERATURE
78. OPN; OPEN
79. PHO#; PHOTOCELL
80. PNT; PAN TEMPERATURE
81. PPM#; PARTS PER MILLION
82. PRF#; PROOF
83. PWR#; POWER
84. PWRFAIL#; ON POWER RETURN POWERFAIL POINT FOR PANELS
85. RAD#; RETURN AIR DAMPER
86. RAE; RETURN AIR ENTHALPY
87. RAH; RETURN AIR HUMIDITY
88. RAT; RETURN AIR TEMPERATURE
89. RCD#; RETURN AIR CARBON DIOXIDE
90. REF#; REFRIGERANT
91. RF#; RETURN (AIR) FAN
92. RMT; ROOM TEMPERATURE
93. RSD#; RETURN SMOKE DETECTOR
94. RSP#; ROOM STATIC PRESSURE
95. RWH#; ROOM HUMIDITY
96. RWT#; RETURN WATER TEMPERATURE
97. SAD#; SUPPLY AIR DAMPER
98. SAT#; SUPPLY AIR TEMPERATURE
99. SCD#; SUPPLY AIR CARBON DIOXIDE
100. SET#; SETPOINT
101. SF#; SUPPLY FAN
102. SFD#; SMOKE/FIRE DAMPER
103. SLT#; SLAB TEMPERATURE
104. SSP#; SUPPLY STATIC PRESSURE (Where # is for multiple sensors)
105. SS#; START/STOP



- 106. SSD#; SUPPLY SMOKE DETECTOR
- 107. START#; START (COMMAND ONLY)
- 108. STATUS#; STATUS
- 109. STB#; STROBE
- 110. SW#; SWITCH
- 111. SWT; SUPPLY WATER TEMPERATURE
- 112. TEC#; TERMINAL EQUIPMENT CONTROLLER
- 113. TECUP#; TEC UPDATE TRIGGER (used with Field Panel system name)
- 114. VAV#; Variable Air Volume Terminal Box Control Systems
- 115. VEP#; VELOCITY PRESSURE
- 116. VSD#; VARIABLE FREQUENCY DRIVE
 - a.) ALM; DRIVE FAULT/ALARM
 - b.) SPD; SPEED COMMAND (%)
 - c.) FBK; SPEED FEEDBACK (Hz)
 - d.) SS; START/STOP WITH STATUS
 - e.) PRF; RUN STATUS
- 117. ZCD#; ZONE CARBON DIOXIDE
- 118. ZN#; ZONE

2.09 SPECIAL CASES

- A. Usernames: Username assignment shall be based upon the requirements of a tenant. Approved and/or acceptable variations to the object naming standard shall be approved by the Owner prior to implementation.
- B. Siemens Program (PPCL) Naming Convention
 - 1. PPCL naming shall STRICTLY follow the object naming.
 - 2. All PPCL names shall be of the format convention;
 - a) PANELNAME.PPCL
 - b) PANELNAME is defined below and will be strictly adhered to.
- C. Field Panel Naming Convention
 - 1. Field Panels shall always be Ethernet connected devices to the FCE provided WAN/LAN.
 - 2. The Hostname and IP parameters of the device on the TCP/IP network shall be provided by the FCE IT Department. See the General BAS Specification for details.
 - 3. The Siemens System Name for the Field Panel shall follow the object naming standard as follows with the except of limited to 25 characters;
 - a) CAMPUSNAME.BUILDINGNAME.RM#.PNL#
 - b) RM# can also be MER# if the panel is located in a Mechanical Space as opposed to a Room with a number.



- D. Terminal Equipment Controllers Naming Convention
 - 1. All TEC equipment types (air boxes, fume hoods, lab controllers, etc. essentially all devices that reside on a floor level network) shall follow the object naming convention as detailed herein.
- E. Graphic Naming Convention
 - 1. All graphic names shall follow the object naming convention.
 - 2. SYSTEMNAME is equal to the SYSTEMNAME used by the majority of the objects the graphic contains.
 - 3. All background graphic files shall be named as follows;
 - a) CAMPUSNAME.BUILDINGNAME.SYSTEMNAME.dsf
 - 4. All Dynamic Graphics shall be named as follows, where (?) is variable;
 - a) CAMPUSNAME.BUILDINGNAME.SYSTEMNAME.?.GRA
 - 5. It is worthy to note here; the name of the graphic is not the name that Siemens would necessarily use when linking to the graphic as defined in the graphic specification of the Master BAS Specification. Graphic linking shall be descriptive and easily navigated.
- F. Report Naming Convention
 - 1. All reports created by Siemens shall follow the object naming convention
 - 2. All reports shall be named as follows, where (?) is variable;
 - a) CAMPUSNAME.BUILDINGNAME.SYSTEMNAME.?.RPT
- G. Network Naming Conventions
 - 1. All Networks shall have a full English Language description at the CSS.
- H. CU Naming Convention
 - 1. The HostName and IP parameters of the device on the TCP/IP network shall be provided by the Owner. See the General BAS Specification for details.
- I. Zone and Event Naming Convention
 - 1. All zones and events shall be named as follows;
 - a) CAMPUS.BUILDING.MACROLEVELNAME.ZN#
 - b) CAMPUS.BUILDING.MACROLEVELNAME.EV#

EXECUTION

3.01 EXAMPLES

- A. Point Names;
 - 1. Anderson, Air Handling Unit 3, Discharge Air Sensor.
 - a) System Name: MAN.AH.AHU03.SAT
 - 2. McKinley, Air Handling Unit 2, down duct static sensor
 - a) System Name: MAN.MK.AHU02.SSP



3. Kerwin, cooling tower 3 fan speed feedback.
 - a) System Name: MAN.KE.CT03.VFD.FBK
4. Hughes, boiler system 2, pump 4 start/stop.
 - a) System Name: MAN.HH.BLR02.HWP04.SS
5. Gray, building differential pressure sensor.
 - a) System Name: MAN.GR.BDP
6. Clark, exhaust fan 4, start/stop.
 - a) System Name: MAN.CK.EF04.SS

END OF SECTION



25 95 00 CONTROL SEQUENCES FOR HVAC

GENERAL

1.01 SECTION INCLUDES

- A. Description of Work
- B. Control Sequences General Requirements
- C. System Specific Control Sequences

1.02 DESCRIPTION OF WORK

- A. This Section defines the manner and method by which controls operate and sequence the controlled equipment.
- B. Included in this section are general requirements and logic strategies that supplement the specific sequences shown on the drawings and included in this Section and its sub-sections.
- C. Refer to the control drawings for specific sequences for individual systems.

1.03 GENERAL REQUIREMENTS

- A. Sequences specified herein indicate the functional intent of the systems operation and may not fully detail every aspect of the programming that may be required to obtain the indicated operation. The contractor shall provide all programming necessary to obtain the sequences/system operation indicated.
- B. Refer to the control drawings for system and application specific sequences.

1.04 PROGRAMMING REQUIREMENTS

- A. Unless specified otherwise, throttling ranges, proportional bands, and cycle differentials shall be centered on the associated setpoint. All modulating feedback control loops shall include the capability of having proportional, integral, and derivative action. Unless the loop is specified "proportional only" or "P+I", Contractor shall apply appropriate elements of integral and derivative gain to each control loop which shall result in stable operation, minimum settling time, and shall maintain the primary variable within the specified maximum allowable variance.
- B. All timing devices, alarm set points and control set points shall be adjustable. Set points listed herein for duct/room static pressure control, differential pressure control for discharge/intake isolation dampers, outside airflow control, return fan airflow tracking volume, and static pressure safeties are initial starting values.
- C. There are several control parameters (e.g., temperature, humidity, etc.) which are required to be maintained within a specified control tolerance. All specified control tolerances shall be met or exceeded.



- D. See Sections 25 55 00 for Control Accuracy and Reporting Performance Parameters for alarming configuration unless this Section provides specific values for any particular alarmable point.
- E. Where any sequence or occupancy schedule calls for more than one motorized unit to start simultaneously, the BAS start commands shall be staggered by 5 second (adj.) intervals to minimize inrush current.
- F. Alarm messages specified throughout the sequences are assigned to discrete priority levels. Priority levels dictate the handling and destination of alarm reports and are defined in Section 25 15 16.
- G. Wherever a value is indicated as adjustable (adj.), it shall be modifiable, with the proper password level, from the operator interface or via a function block menu. For these points, it is unacceptable to have to modify programming statements to change the setpoint.
- H. All initial setpoints, ranges, flow coefficients and variables shall be written into the programming for each control system zone as comments and placed on the relevant graphic.
- I. All analog control values regardless of physical range, i.e., 0-10V, 4-20mA, etc., shall be configured to present a value between 0-100% where 0% is always closed and 100% is always open. AU requests the graphic show 0% open for a closed damper and 100% open for a fully open damper.
- J. All values that represent a number less than zero shall be represented with a minus sign in front of the number. An example, all exhaust static setpoints and pressures shall be negative.
- K. Whenever the BAS system senses the status of an operating component, whether the command is initiated or not, for instance if a drive is commanded to hand locally, the BAS shall operate all control loops.
- L. Wherever a value is indicated to be dependent on another value (i.e.: setpoint plus 5°F) BAS shall use that equation to determine the value. Simply providing a virtual point that the operator must set is unacceptable. In this case three virtual points shall be provided. One to store the parameter (5°F), one to store the setpoint, and one to store the value which is the result of the equation.
- M. All calculations that require establishing the state of a static pressure sensor shall perform the following:
 - 1. A failed sensor shall indicate as zero in the calculation.
 - 2. If multiple sensors are measuring a common system duct, the calculation shall not include the failed sensor.
 - 3. Failed sensor(s) shall be an alarm condition.
 - 4. A virtual point definition shall exist in the controller that requires the static status, not the controller providing the status. For example, an exhaust status point shall be defined in the supply controller and the programming setting its value shall reside in the exhaust controller.



- N. All variable geometry discharge dampers (VGDD's) shall be programmed per the following logic. All parameters to calculate and validate airflows shall be available, adjustable and initial settings hard coded in programming. The calculation to determine the proper control shall be as follows;
1. Loop Input: Fan Flow in CFM * Current Discharge Opening in square feet.
 2. Loop Output: VGDD signal, scaled to 0-100% where zero is minimum.
 3. Loop Setpoint: EF Discharge Stack Flow Setpoint, initial value of 3500 feet per minute.
- O. To calculate the points required for proper chiller staging, use the following formulas;
1. Excess Capacity: This is equal to the rated tonnage of all online chillers minus the actual plant tonnage. The actual plant tonnage is equal to the sum of each chillers actual tonnage.
 2. Chiller Actual Tonnage: Chiller Tonnage Nameplate Rating*Chiller Current Load Value. The Chiller Current Load Value is determined by the chiller control panel and provided to the BAS via the hard-wired Chiller Load point. This value is received and displayed as a percentage, but for this calculation, it shall be converted to a decimal.
- P. Sensor Control: The required standards for programming to address a sensors ability to be disabled from control while in maintenance mode or failed shall be as follows;
1. Virtual AI = (Sensor Status)*(Sensor Maintenance Mode)*(Sensor Actual Value)
 - a) Virtual AI is the virtual analog input value used for any calculation or input control. In some cases, for example exhaust static sensors, the minimum of a number of these values would be used as the input for control.
 - b) Maintenance Mode is a Virtual BO so its value is always zero or one.
 - c) Sensor Status is always either Failed (value = 0) or Normal (value = 1).
- Q. Access Control to Laboratories, Vivarium and Museums Variables:
1. All setpoints, operational mode points, control points shall be placed on the zone/space parameters graphic and protected from change by the highest level of operator access control.

1.05 SCHEDULING TERMINOLOGY

- A. When a control system is scheduled throughout the day, the following defines the terminology used:

Occupied Period: The period when the area served by the specific control system or zone is in use and occupied. Coordinate the initial occupied schedule with AU. Generally, systems will be fully operational throughout



this period and ventilation air shall be continuously introduced. Initial space temperature setpoints shall be applied per the American University Temperature Policy. Request the current AU Temperature Policy parameters from the AU BAS Department prior to entering set points.

2. Unoccupied period: The period when the area served by the specific control system or zone is not in use and unoccupied. By default, all Federal holidays (see AU website for list of observed Federal holidays) shall be unoccupied periods with the capability to modify in the future.
3. Preoccupancy Period: A time span prior to the Occupied period. Examples are AHU warm-up and cool-down. AHU Economizers will function normally. The duration and start time of this period shall be determined by an optimum start strategy unless otherwise specified.
4. Setback Period: This period will typically start with the end of the occupied period and end with the start of the preoccupancy period; however, it shall be provided with its own schedule. Generally, systems will be off except to maintain a “setback” temperature.
5. Demand Response Period: This period is available during all other periods. When activated the control system is placed into a shutdown mode in order to reduce energy consumed.

1.06 RESET STRATEGIES

- A. Where reset action is specified in a sequence of operation, but a reset schedule is not indicated on the drawings, one of the following methods shall be employed:
 1. The contractor shall determine a fixed reset schedule that shall result in stable operation and shall maintain the primary variable within the specified maximum allowable variance.
 2. A floating reset algorithm shall be used which increments the secondary variable setpoint (setpoint of control loop being reset) on a periodic basis to maintain primary variable setpoint. The recalculation time and reset increment shall be chosen to maintain the primary variable within the specified maximum allowable variance.
- B. Where a supply air temperature setpoint is specified to be reset by the space temperature of the zones calling for the most cooling/heating, the following method shall be employed:
 1. A floating reset algorithm shall be used which increments the secondary variable, supply air temperature setpoint, on a periodic basis to maintain primary variable (e.g. space temperature) setpoint. The reset increment shall be determined by the quantity of “need heat” or “need cool” requests from individual Terminal Control Units. A TCU’s “need heat” virtual point shall activate whenever the zone’s space temperature falls below the currently applicable (occupied or unoccupied) heating setpoint throttling range. A TCU’s “need cool” virtual point shall activate whenever the zone’s space temperature rises above the currently



applicable (occupied, unoccupied, or economy) cooling setpoint throttling range. The recalculation time and reset increment shall be chosen to maintain the primary variable within the specified maximum allowable variance while minimizing overshoot and settling time. Reset range maximum and minimum values shall limit the setpoint range.

- C. Where a duct pressure, or differential water pressure setpoint is specified to be reset by valve or damper position of the zone or zones calling for the most cooling/heating, the following method shall be employed:
 - 1. A floating reset algorithm shall be used which increments the secondary variable (e.g., pipe or duct pressure) setpoint on a periodic basis to maintain primary variable (e.g. cooling valve, heating valve, damper position) setpoint of 85% open. The reset increment shall be calculated based on the average position of the quantity of the worst (most open valve/damper) zone(s) as specified. The recalculation time, reset increment and control device position influence shall be chosen to maintain the primary variable within the specified maximum allowable variance while minimizing overshoot and settling time. The BAS analog output value shall be acceptable as indicating the position of the control device.
 - 2. Alternatively, to continuously calculating the average of the quantity of worst valve/damper positions, a method similar to the one described above may be employed whereby the “need heat” or “need cool” virtual point shall increment by one unit each time a zone’s valve/damper position rises to greater than 95%. The quantity of “need heat” or “need cool” points shall then be the basis for reset.

1.07 PROOF STRATEGIES

- A. Where “prove operation” of a device (generally controlled by a digital output) is indicated in the sequence, it shall require the BAS, after an adjustable time delay after the device is commanded to operate (feedback delay), confirm that the device is operational via the status input.
- B. If the status point does not confirm operation after the time delay or anytime thereafter for an adjustable time delay (chatter delay) while the device is commanded to run, an alarm shall be enunciated audibly and via an alarm message at the operator interface and print at the alarm printers. A descriptive message shall be attached to the alarm message indicating the nature of the alarm and actions to be taken. The contractor shall provide messages to meet this intent.
- C. Upon failure, the run command shall be removed, and the device shall be locked out in software until the alarm is manually acknowledged unless specified otherwise.



PRODUCTS

2.01 NOT USED

EXECUTION

3.01 PROJECT SYSTEM NAMING

- A. All objects contained within the BAS shall use the Object Naming specification. See Section 25 5500.13 for details.

3.02 GENERAL

- A. Emergency Shutdown is a special software switch that when activated must command all air moving equipment OFF and exterior dampers (outside air, exhaust air, relief air) CLOSED. Coordinate integration of this network point with all fans and dampers under BAS control for this project.

Provide building level software button for all systems to shutdown per building, and campus level software button for all system on campus to shut down. Integrate manual shutdown button in central plant with campus level shutdown sequence.

- B. Outside air sensor backup programming: Whenever the local building outside air sensor is determined to have failed or be unreliable by the BAS the BAS shall automatically connect to a remote outside air sensor for outside air data.
- C. Winter Break Setback is a special software switch that when activated sets all zone level terminal units and single zone space control equipment to a heating setback temperature setpoint of 53 degrees F (adj.). The Winter Break Setback switch shall automatically revert to normal temperature setpoints at the end of the Winter Break scheduled period.
- D. Zone temperature adjustment: Provide a means for the BAS operator to adjust space temperature set points per space, per floor, or per building. For example, there shall be a means for the BAS operator to change all of the space temperature set points in a building from a single operation and not require the operator to change the set point at each space separately.

3.03 AIR HANDLER UNITS

- A. When an air handling unit is not in operation, control devices shall remain in their "off" positions. "Off" positions may differ from the "normal" (meaning failed) position. Except as specified otherwise, "off" and "normal" positions of control devices shall be as follows:



Device	“Off” Position	“Normal” Position
Heating Coil Valves	Closed/Controlling	Open
Cooling Coil Valves	Closed	Closed
Outside Air Damper	Closed	Closed
Return Air Damper	Open	Open
Exhaust Air Damper	Closed	Closed
Var. Freq. Drive	Off	Min. Speed

B. Logic Strategies: The BAS shall fully control the air handlers. Generally, the BAS shall energize the AHU (start the fans and activate control loops) as dictated for each air handler. The following indicates when and how the BAS shall energize the AHUs and control various common aspects of them:

1. Scheduled Occupancy: BAS shall determine the occupancy periods (occupied, unoccupied, preoccupancy, and setback) as defined above. The following details the common control aspects related to the scheduled occupancy.
 - a) Occupied Period: BAS shall energize the AHU during all occupied periods. Note that the beginning of the occupancy period shall be set sufficiently before the actual start of occupancy to obtain the required building component of ventilation per ASHREA 62. Minimum OA flow setpoint shall be as scheduled on the drawings. “Normal” setpoints shall apply.
 - b) Unoccupied Period: Minimum OA flow shall be 0 CFM or the minimum OA damper position shall be 0%. If during the unoccupied period there is a request for occupancy override, the occupancy mode shall become active for an adjustable period. The unoccupied period and the preoccupancy period will typically overlap.
 - c) Setback Period: the BAS shall deenergize the unit except as required to maintain a setback temperature as indicated in the individual sequences with a 5°F cycle differential. Generally, where setback temperatures apply in multiple zones, the worst zone shall control the system. Setback setpoints generally apply except during preoccupancy [and night purge]. If during the unoccupied period there is a request for occupancy override, the occupancy mode shall become active for an adjustable period.
 - d) Preoccupancy: BAS shall energize the AH continuously during the preoccupancy period. Minimum OA flow shall be 0 CFM or the minimum OA damper position shall be 0%. “Normal” setpoints shall apply. Preoccupancy duration shall be one of the following as specified by reference:

- 1) Fixed: The duration of the preoccupancy period shall be fixed



as scheduled by the operator.

- 2) Optimum: The duration of the morning warm-up period shall vary according to outside air temperature and space temperature such that the space temperature rises to occupied period heating setpoint at the beginning of, but not before, the scheduled occupied period. The duration of the cool-down period shall vary according to outside air temperature and space temperature such that the space temperature falls to the occupied period cooling setpoint at the beginning of, but not before, the scheduled occupied period
2. Minimum OA Control: BAS shall maintain minimum ventilation during the occupied period. The following strategies may apply:
 - a) Balanced Position: During the occupied period, applicable mixing and OA dampers shall never be positioned less than the position set for the required minimum OA ventilation rate. If the air handler has a single OA damper that is capable of economizer, the minimum position output shall be determined by the balancer. If the AH has a two-position minimum OA damper, that position shall be fully open to its balanced position. This logic strategy is only applicable to constant volume AHs.
 - b) Reset Balanced Position: During the occupied period, applicable mixing and OA dampers shall never be positioned less than the minimum position. The minimum position shall be reset between limits of a position delivering system exhaust make-up air CFM and the design minimum position delivering design minimum CFM to maintain a CO₂ setpoint of 400 ppm (adj.) above the outdoor air CO₂ level. Loop shall be a “sample and bump” or dynamic proportional only loop tuned for the slow response. The balancer shall determine the minimum position outputs at both extreme points. This logic strategy is only applicable to constant volume AHUs.
 - c) Damper Controlled Fixed: During the occupied period, applicable mixing dampers shall be modulated to maintain an OA flow rate of no less than the minimum ventilation requirement (MVR) as dictated in the design and required by code. Setpoint flow rates shall be provided by the A/E.
 - d) Damper Controlled Reset: During the occupied period, applicable mixing dampers shall be modulated to maintain an OA flow rate setpoint. Setpoint shall be reset between limits of system exhaust make-up air CFM and the design minimum CFM to maintain an RA CO₂ setpoint of 900 ppm (adj.). Loop shall be a “sample and bump” or dynamic proportional only loop tuned for the slow response. Setpoint flow rates shall be provided by the A/E.
 - e) Mixed Air Temperature Control: Minimum position of the OA damper shall be set to obtain the design required minimum OA. This balanced minimum position shall remain fixed.



Whenever the minimum loop is active BAS shall control the dampers to maintain a mixed air temperature setpoint that will be 2°F below AHU discharge air temperature cooling setpoint (adj.).

3. VAV Return Fan Capacity Control: BAS shall control the output of the return fan as follows:
 - a) Flow Tracking: The return air fan shall run to maintain a return flow setpoint of the supply flow minus an offset value. The offset value shall be determined as follows.
 - 1) Fixed Differential: It shall be fixed at the design minimum OA value.
 - 2) Differential Reset from RA CO₂: It shall be reset between limits of system exhaust make-up air CFM and the design minimum CFM to maintain an RA CO₂ setpoint of 900 ppm (adj.). Loop shall be a “sample and bump” or dynamic proportional only loop tuned for the slow response. Setpoint flow rates shall be provided by the A/E.
 - 3) Differential Reset From Measured OA to Maintain Fixed OA: It shall be reset to maintain the measured minimum OA flow at the design value any time the economizer mode is inactive. Whenever it is inactive, it shall be set to the value that existed when the unit became active.
 - 4) Differential Reset From Measured OA to Maintain Reset OA: When the economizer mode is inactive, it shall be reset to maintain the measured OA flow setpoint. The OA setpoint shall be reset between limits of system exhaust make-up air CFM and the design minimum CFM to maintain a CO₂ setpoint of 900 ppm (adj.). Loop shall be a “sample and bump” or dynamic proportional only loop tuned for the slow response. Setpoint flow rates shall be provided by the A/E. Whenever the economizer is active, it shall be set to the value that existed when the unit became active.
 - b) Rescaled Output Capacity Control: The output for the return fan capacity control shall be rescaled from the output of the to the supply device such that the design minimum OA flow is maintained at both maximum and 50% flow conditions. The balancing contractor shall determine the coordinated output.
4. Airside Economizer: BAS shall modulate the mixing dampers to provide “free cooling” when conditions merit. The free cooling shall generally be staged before any mechanical cooling. While conditions merit, dampers shall be modulated in a DA PID loop to maintain mixed air temperature at a setpoint as specified for the individual unit. Economizer logic shall remain enabled during setback cooling where applicable. The following strategy shall be used to enable the economizer mode:
 - a) Dry Bulb Switch: Economizer mode shall be active while the unit is



energized AND when outside air temperature falls below the switching setpoint of 55°F (adj.) (with 5°F cycle differential). Economizer mode shall be inactive when outside air temperature rises above switching setpoint, dampers shall return to their scheduled minimum positions as specified above.

5. Sequenced Heating and Cooling: BAS shall control the heating and cooling coils and air side economizer as detailed for the AH. Program logic shall directly prohibit the heating and cooling valves as well as the heating valve and economizer damper to be open (or above minimum) simultaneously. This does not apply to cooling and reheat valves that are used simultaneously for dehumidification.
6. Mixed Air Low Limit Override: BAS shall override the signal to the OA damper via a proportional only loop to maintain a minimum mixed air temperature of 45°F (adj.) (loop shall output 0% at 45°F which shall be passed to the output via a low selector).
7. Freeze Safety: Upon operation of a Freezestat the following sequence shall occur:
 - a) The unit fans shall be deenergized. Typically supply and return fans where applicable shall be deenergized via a hardwired interlock, and an indication of the operation shall be displayed by the BAS.
 - b) All hot water valves and chilled water valves will be commanded to 100% open. Steam preheat valves shall modulate to maintain minimum preheat/mixed air plenum temperature.
 - c) All hot water coil pumps and chilled water coil pumps will be commanded to run.
 - d) Outside air dampers shall fully close and return air dampers shall fully open.
 - e) BAS shall enunciate appropriate alarm and remove and lock out the start command, which shall initiate "fan failure" alarms.
8. Smoke Safety: Upon indication of smoke by a smoke detector, FAC shall override all AH control. FAC shall not rely on BAS for implementation of smoke control sequences unless specifically approved. Smoke detector shall notify the fire alarm system and BAS, shut down the fans, and close the smoke dampers via hard-wired interlock.
9. Smoke Pressurization Cycle: When pressurization is commanded by the interface to the fire alarm system, the supply fan shall start and deliver 100% outside air to the space. Return fan shall remain off. Hardwired interlock from safeties may still interrupt fan operation. (See damper and heating valve sequences for additional sequences associated with pressurization.)
10. Smoke Exhaust Cycle: when exhaust is commanded by the interface to the fire alarm system, the return fan shall start and shall exhaust 100% return air from the space. Supply fan shall remain off. (See damper and



heating valve sequences for additional sequences associated with pressurization.)

11. High or Low Pressure Safety: Upon activation of a high or low pressure safety switch, AH shall be deenergized, fans shall be deenergized via a hard wired interlock, and an indication of the operation shall be sensed by the BAS. BAS shall enunciate appropriate alarm and remove and lock out the start command, which shall initiate "fan failure" alarms.
 12. Vibration Safety (Applicable To Units >50,000 cfm): Upon activation of a vibration safety switch, respective fan shall be deenergized, fan shall be deenergized via a hard wired interlock and an indication of the operation shall be sensed by the BAS. BAS shall enunciate appropriate alarm and remove and lock out the start command.
- C. The detailed "logic strategies" above shall be required by reference to them in each of the individual sequences specified.

3.04 AIR HANDLING UNIT DIAGNOSTICS

- A. Diagnostic Strategies: In addition to the standard alarm limits specified for all sensed variables the BAS monitor and diagnose anomalies in the operation of the air handlers. The following "diagnostic strategies" shall be included by reference with each air handler with any specific clarifications required:
1. Run Time Limit: BAS shall accumulate the runtime of the status of associated rotating equipment and enunciate an alarm to indicate that the unit is in need of service.
 2. Filter Monitoring: BAS shall monitor the differential pressure transmitter across the filter bank(s). An alarm shall be reported when pressure drop exceeds the transmitter's setting.
 3. Start Monitoring: BAS shall accumulate the starts of cycling equipment. BAS shall further enunciate an alarm when the number of starts exceeds the specified value within the specified time period. (ie: more than 3 starts in a 30 min period).

3.05 ENERGY CURTAILMENT CONTROL

- A. BAS shall monitor kW demand over a 15-minute sliding period.
- B. The operator (with appropriate password level) at the OWS shall manually enable demand limiting. Demand limiting shall remain enabled until manually disabled by the operator at the OWS.
- C. On a rise in kW to within 200 kW (adj.) of setpoint, a Level 4 alarm shall be enunciated and BAS shall begin to make one "load shed" command every 10 minutes (adj.). On a fall in kW to 200 kW less than the demand setpoint, BAS shall begin to broadcast one "load restore" command every 5 (adj.) minutes on a first shed, first restored basis.

Automatic load shedding shall be limited to a maximum of two (adj.) load



shed commands. Once the maximum automated load shed has been reached and demand still exceeds the demand, setpoint the operator will be notified via Level 3 alarm that additional load shedding will require manual intervention.

Operators with required user access shall be able to manually initiate additional load shed commands.

- D. Coordinate which loads are available for shedding with the Owner.
- E. Load shedding commands priority:
 - 1. The first load shed command shall reset terminal level equipment space temperature set points to their set back values over a [5] minute (adj.) period.
 - 2. The second load shed command shall reset VAV air handler down duct static set points to their minimum value over a [10] minute (adj.) period.
 - 3. The third load shed command shall reset central plant equipment to their minimum capacity set points over a [30] minute (adj.) period.
- F. On a rise in kW to within 50 kW (adj.) of setpoint, a Level 3 and Level 4 alarm shall be enunciated.

3.06 GENERAL PRIMARY/SECONDARY CHW SYSTEMS CONTROL

- A. All Chiller Start/Stop sequences and design elements are to be reviewed by the Owner prior to approval.
- B. General: BAS shall fully control the chilled water systems and equipment and shall provide monitoring and diagnostic information for management purposes. The following logic strategies are referenced in the individual sequences and expand on the requirements:
- C. Cooling Enable: As indicated on the drawings for the specific system.
- D. Chilled Water Load Determination:
 - 1. Chilled water load shall be calculated instantaneously from the flow and temperature difference of the following loops:
 - a) Primary loop total.
 - b) Individual chiller circuits.
 - c) Individual secondary circuits (as applicable)
 - 2. Chilled water load for the purposes of the staging of the chillers shall be calculated as the 10 min average of the secondary circuit loads.
- E. Chiller Staging: Chiller shall be staged as specified below.
- F. Proof of Chiller Operation: BAS shall prove the operation of the chillers via chiller status and alarm points. When a chiller is assessed as failed, the run command shall be locked out and shall require manual acknowledgment at the operator interface before it is restarted. BAS shall then start the next chiller in rotation. The following conditions shall result in the assessment that the chiller has failed:
 - 1. Loss of chiller status for more than 15s (adj.) while it is requested.



2. Closure of chiller failure input.
 3. Leaving chilled water temperature exceeds chiller setpoint plus 8°F for 10 min. continuously.
 4. Chiller environment is unacceptable for 10 min. as specified below.
- G. Chiller Environment Monitoring: BAS shall monitor the “environment” of all active (not starting or stopping) chillers and remove the run command when the environment is assessed as unacceptable. An unacceptable environment will include any of the following:
1. Loss of status on the associated primary pump (pump proof debounce time shall not apply).
 2. Condenser water entering temperature below CHW supply plus 12°F or above 100°F.
 3. Condenser water flow below a minimum setpoint GPM where such flow is measured.
 4. Chilled water flow below a minimum setpoint GPM.
- H. When the environment is assessed as unacceptable, the BAS shall enunciate an alarm, remove chiller run command (not the chiller request; all supporting equipment shall continue to operate) and start a timer. If the environment is still unacceptable after 10 min. (adj.), fail the chiller.
- I. Chiller Request: A chiller request is the request for a chiller and the associated equipment. A chiller request is issued before the actual run command to the chiller, which is the closure of the physical point that enables the chiller.
- J. Chilled Water Temperature Control: The chilled water temperature shall be controlled as specified below.

3.07 CHILLER STAGING (T ON L OFF)

- A. BAS shall control the starting and stopping of chillers to meet the demands of the secondary chilled water systems (SCHW). Whenever cooling is requested, a minimum of one chiller shall be requested. Chillers shall be started per the chiller start sequence and stopped per the chiller stop sequence specified below. Once the conditions merit starting or stopping a chiller, BAS shall complete the starting or stopping sequence regardless of temperature fluctuations during the sequence. Additional chillers shall be started based on SCHW supply temperature as follows:
1. For the purposes of chiller staging control, a virtual point called “average secondary chilled water supply temperature” (ASCHWST) shall be continuously calculated and displayed. This value shall be the 10-minute average of the instantaneously sensed secondary chilled water supply temperature.
 2. An additional chiller shall be requested and started per the chiller start sequence specified below when:



- a) The ASCHWST rises more than 4°F above the secondary chilled water supply setpoint for 5 min. (adj.) continuously, AND
 - b) More than 30 min. (adj.) has elapsed since the start of the last chiller.
3. Chillers shall be stopped, per the chiller stop sequence specified below, based on the averaged cooling load as follows:
- a) One chiller shall be stopped when the load falls below (Total Nominal Capacity-(Nominal Capacity of Last Chiller) * 1.2), AND
 - b) A minimum of 15 min. has elapsed since a chiller has been stopped, AND
 - c) A minimum of 30 min. has elapsed since this chiller has been started.

3.08 CHILLER STAGING (LOAD)

- A. BAS shall control the starting and stopping of chillers to meet the demands of the [secondary] chilled water systems. Whenever cooling is requested, a minimum of one chiller shall be requested. Chillers shall be started per the chiller start sequence and stopped per the chiller stop sequence specified below.

Once the conditions merit starting or stopping a chiller, BAS shall complete the starting or stopping sequence regardless of temperature fluctuations during the sequence. Additional chillers shall be started based on SCHW load as follows:

1. An additional chiller shall be requested and started per the chiller start sequence specified below when:
 - a) The average cooling load rises above 90% of the nominal capacity of the active chillers for 5 min. (adj.) continuously, AND
 - b) More than 30 min. (adj.) has elapsed since the start of the last chiller.
2. Chillers shall be stopped, per the chiller stop sequence specified below, based on the averaged cooling load as follows:
 - a) One chiller shall be stopped when the load falls below (Total Nominal Capacity-(Nominal Capacity of Last Chiller) * 1.2), AND
 - b) A minimum of 15 min. has elapsed since a chiller has been stopped, AND
 - c) A minimum of 30 min. has elapsed since this chiller has been started.

3.09 CHILLER STAGING (CHILLER AMPS)

- A. BAS shall control the starting and stopping of chillers to meet the demands of the secondary chilled water systems. Whenever cooling is requested, a minimum of one chiller shall be requested. Chillers shall be started per the chiller start sequence and stopped per the chiller stop sequence specified



below.

Once the conditions merit starting or stopping a chiller, BAS shall complete the starting or stopping sequence regardless of temperature fluctuations during the sequence. Additional chillers shall be started based the amperage drawn by the chiller as follows:

1. An additional chiller shall be requested and started per the chiller start sequence specified below when:
 - a) The average percent amperage drawn by the active chillers rises above 95% of the nominal full load amperage of the active chillers for 5 min. (adj.) continuously, AND
 - b) More than 30 min. (adj.) has elapsed since the start of the last chiller.
2. Chillers shall be stopped, per the chiller stop sequence specified below, based on the averaged cooling load as follows:
 - a) One chiller shall be stopped when the load falls below (Total Nominal Amperage-(Nominal Amperage of Last Chiller) * 1.2), AND
 - b) A minimum of 15 min. has elapsed since a chiller has been stopped, AND
 - c) A minimum of 30 min. has elapsed since this chiller has been started.

3.10 PRIMARY CHW PUMP CONTROL (ONE PUMP/CHILLER)

- A. Primary pumps shall be started to serve their respective chiller when it is requested to run per the chiller start and stop sequences specified below. Pumps shall run continuously when the respective chiller is requested. BAS shall prove operation of the pump.

3.11 SECONDARY CHW PUMP (WITH VFD) CONTROL

- A. Secondary pumps shall run continuously whenever cooling is requested from the system it is serving or when system is enabled by the operator. BAS shall prove operation of the pump. BAS shall vary the speed of the pumps to maintain the lowest differential pressure setpoint across any of the applicable differential pressure sensors. The differential pressure setpoint shall either be fixed at 10 psi (adj.) or reset between 5 psi (adj.) and 15 psi (adj.) based on one of the following as indicated specifically on the drawing sequences:
 1. Valve position, OR
 2. Cooling requests from the applicable secondary terminals.

3.12 CONDENSER WATER PUMP CONTROL (ONE PUMP/CHILLER)

- A. Pumps shall be started per the chiller start and stop sequences specified below to serve their respective chiller when the chiller is requested to run. Pumps shall run continuously when their chiller is requested. BAS shall



prove operation of the pumps.

3.13 COOLING TOWER BYPASS VALVE CONTROL

- A. BAS shall control the bypass valve via a PID control loop to maintain a minimum mixed condenser water temperature of 65°F when systems are in mechanical cooling mode.

3.14 CHILLER PRIORITY SELECTION (EQUAL SIZE AND EFFICIENCY CHILLERS)

- A. BAS shall automatically prioritize the chillers for starting order. One of the following methods shall be employed to rotate and re-prioritize the chillers:
 1. The chiller with the least run time shall be started first and the chiller with the greatest runtime shall be stopped first.
 2. The BAS shall provide a graphic screen to support the manual selection of chiller priorities.
 3. The chiller priorities shall be rotated based on a predetermined schedule. Owner shall dictate a regular schedule for the priorities to be switched.
- B. Operators shall be able to lock out chillers in "Maintenance Mode. This means that the requests for this chiller and associated appurtenances shall be bypassed. This shall be done through a graphic icon associated with a virtual point indicating whether the maintenance mode is active or via a property associated with the chiller icon.

3.15 CHILLER START SEQUENCE

- A. On a request for a chiller to start as specified above under "Chiller Staging," the following sequence shall occur:
 1. Wait thirty seconds (adj.).
 2. Enable additional cooling towers as specified above (if applicable). This shall enable the bypass valve control loop if it is not already enabled. Then command the isolation valves to open. The travel rate of the tower isolation valves shall be limited to ease the shock on the tower water system leaving temperature during cold weather. For systems that allow tower piping to drain when the system is off, upon start up fully close bypass valve for 30 seconds (adj.) to prime the system and eject air when the system is first started.
 3. Gradually reset the demand limit to all active chillers from 100% to 50% (adj.) of maximum amps.
 4. Request the start of the applicable condenser water pump and prove operation.
 5. After condenser pump operation is proven, BAS shall start the applicable primary chilled water pump and prove operation. Concurrently with the starting of the chilled water pumps, BAS shall open the chiller isolation valve (if applicable) at a limited rate of travel



to minimize the shock to other operational chillers.

6. Wait a maximum of 5 min. after the command to start the condenser pump for the chiller environment as specified above to be acceptable. As soon as the environment is assessed as acceptable, continue the start sequence. If after 5 min. the environment is not acceptable, fail the chiller and start the next chiller.
7. Command the chiller to start under its own control.
8. Monitor chiller status and prove operation. If status is not indicated within 3 minutes (adj.) of a command to start, announce an alarm, disable and lock out chiller.
9. After status is proven, gradually reset current limit to all active chillers to 100%.

3.16 CHILLER STOP SEQUENCE

- A. When a chiller is no longer needed as specified in chiller staging, the following sequence shall occur:
 1. Remove chiller run command.
 2. Wait for status to clear and for the chiller to stop under control.
 3. Wait 1 min. (adj.). Then, where applicable, begin to modulate closed the isolation valve. At mid-stroke stop associated PCHW pump.
 4. Where applicable, begin to stroke the condenser isolation valve closed and at mid stroke, stop the condenser pump.
 5. Close applicable tower isolation valves and, if this is the last chiller running on the circuit, close the applicable bypass valve.

3.17 GENERAL HEATING WATER SYSTEMS CONTROL

- A. General: BAS shall fully control the hot water systems and equipment and provide monitoring and diagnostic information for management purposes. The following logic strategies are referenced in the individual sequences and expand on the requirements.
- B. Heating Enable: Heating shall be enabled as indicated on the drawing sequence.
- C. Hot Water Load Determination
 1. Hot water load shall be calculated instantaneously from the flow and temperature difference of the following loops:
 - a) Primary loop total.
 - b) Individual boiler circuits.
 - c) Individual secondary circuits.
 2. Hot water load for the purposes of the staging of the chillers shall be calculated as the 10 min average of the secondary circuit loads.



3.18 CENTRAL PLANT MONITORING AND MANAGEMENT

- A. General: The BAS shall monitor various aspects of the heating and cooling systems and calculate parameters as specified below to facilitate plant operations and management.
- B. Trending: The BAS shall continuously monitor, calculate, and display the following parameters at the intervals indicated. These values shall be stored initially in the buffer of the controlling control unit, and then be uploaded periodically and stored on a specified hard disc. Contractor shall format reports from this data to support one of the following data formats:
 - 1. Quote (text strings) and Comma delimited.
 - 2. Microsoft EXCEL.
 - 3. Microsoft ACCESS.
- C. Parameters to be Trended:
 - 1. Load on the secondary systems in MMBTU (IT) / hr per the following equation: $(\text{Return Temp} - \text{Supply Temp}) * (\text{GPM}) / .5$. This shows cooling as a positive heat load and heating as a negative heat load. This value shall be trended and stored every two hours.
 - 2. All temperature sensors at 15-minute intervals.
 - 3. All relative humidity sensors at 15-minute intervals.
 - 4. All pressure sensors at 15-minute intervals.
 - 5. All run requests and statuses on a change in value.
 - 6. All analog loop outputs on 15-minute intervals.
 - 7. Calculated enthalpies in 2-hour intervals.
 - 8. Summed cooling and heating requests on 2-hour intervals.

3.19 VARIABLE FREQUENCY DRIVES

- A. Coordinate the following requirements with the VFD vendor:
 - 1. All drives shall include network and hardwired BAS interface options.
 - 2. Drive shall be configured for auto-restart on power return when the run command is indicated.
 - 3. Drive shall be configured to start into a forward or backward rotating fan wheel when the run command is indicated. Drive shall catch the wheel at its speed and accelerate directly to the indicated reference speed.
 - 4. Drive shall be configured to stop the fan at the fastest, mechanically safest possible rate to assure as low a static pressure as possible during the turndown period.
 - 5. Drive shall be configured such that upon loss of BAS speed reference



signal the drive shall stop.

6. Preset speed signal shall be set up to limit the operating speed of the drive to an adjustable parameter (typically 25 Hz) when there is an open contact across it. This value shall be adjusted during Cx to ensure smooth transitions into an operating header and a safe pressure against the dead head of the dampers.
7. Drive shall be configured to stop when any load side disconnect switch is placed in the OPEN position. The drive shall be allowed to return with normal operations when all load side disconnect switches are placed in the CLOSED position.
8. Drive shall be configured to initiate a common alarm to the BAS whenever there is a fault detected.
9. All TAB established drive programming shall be included on a BAS CSS Graphic for informational purposes. Each value shall include the default value and the custom programming value with a brief description of the customization's purpose.
10. Each VFD shall open all AHU dampers in parallel in accordance with the following:
 - a) In VFD Mode: Upon a run command from the BAS, the drive shall start the fan into closed dampers. It shall start at 0 Hz and accelerate per drive settings (typically 1 Hz per second). When the drive speed exceeds an adjustable speed threshold (typically 20 Hz) the drive shall issue an open command to the fans OA damper and the supply discharge damper via a "drive running" output. The drive shall limit the speed of the fan to the safe preset speed (programmed in the drive) until all dampers are proven open. Once the damper end switches prove open dampers, the drive shall allow the fan to accelerate at the controlled rate to the BAS drive reference signal that is sent via hard-wired interface from the BAS.
 - b) In HAND Mode: The same logic shall apply as VFD Mode when the drive speed signal is in HAND mode and manually controlled through the VFD panel. Preset speed limit shall apply whenever the Inverter is active.

END OF SECTION
END OF DIVISION 25



DIVISION 26 ELECTRICAL

GENERAL

American University's utilities on Campus are owned, operated and maintained by the University. Electrical service to each facility is by connection to the University's electrical distribution system that is managed by Facilities Management (FM). All electrical designs must be reviewed and approved by the FM Director Energy and Engineering and/or a designated representative.

All electrical designs shall comply with national, state and local codes. The Consultant shall incorporate into the design, as a minimum, the industry standards and design criteria in the following references:

- a. National Fire Protection Association (NFPA) Standard 70 National Electrical Code
- b. American National Standards Institute (ANSI) Standard C2 National Electrical Safety Code
- c. Standard Handbook for Electrical Engineers
- d. American Electricians Handbook
- e. NFPA 20 Installation of Centrifugal Fire Pumps
- f. NFPA 30 Flammable and Liquid Combustible Code
- g. NFPA 37 Stationary Combustion Engines and Gas Turbines
- h. NFPA 72 Fire Alarm Systems
- i. NFPA 78 Lightning Protection Code
- j. NFPA 101 Life Safety Code
- k. NFPA 110 Emergency and Backup Power System
- l. National Electrical Manufacturers Association (NEMA) standards for Materials and Products
- m. ANSI standards
- n. Underwriters Laboratories (UL) Fire Resistive Directory
- o. D.C. Building Code
- p. D.C. Division of Facility Service Guidelines



The Consultant shall provide a written description of how the entire system is designed to operate. This Basis of Design (BOD) narrative also shall describe how project objectives are being met. It shall be provided in a format that can be easily understood by a layperson, the end user. The narrative identifies items that specifically meet the Owners Project Requirements (OPR) and the most recent Facilities Management (FM) or department System Master Plan(s) and articulate a rationale for any variance.

For renovations, the systems selected shall be compatible with the existing building's electrical systems. The integrity of the basic existing building system shall not be compromised, except where agreed to by the Owner. Work shall be designed and sequenced to minimize impact and interruptions in occupied buildings.

For site work, the Consultant shall indicate all existing underground work such as piping, valves, manholes, electric wiring and telephone, whether new connections are being made or not. Profiles of all piping need to be shown to facilitate coordination with the crossing of other utilities.

The Consultant shall incorporate any requirements from the University insurance carrier or Risk Management into the design and specifications.

Projects using BIM modeling shall detail all manufacturer's requirements for equipment service clearances.

Life cycle cost/present worth analyses that assess total costs of certain electrical components over their useful life may be required on selected projects.

ELECTRICAL SYSTEMS DESIGN CRITERIA

The Consultant shall be guided by the following principles when creating the design and when specifying equipment, methods and materials:

- design shall meet all Owner objectives
- equipment and materials specified shall be well-suited for the specific application



- equipment and materials shall be high-quality products from approved manufacturers, selected for ease of installation, durability, low maintenance and high reliability
- electrical systems shall be sized to accommodate future loads
- electrical system components shall be energy efficient when compared to standard products by the same manufacturer
- all conductors are to be copper

LABELING

Label electric circuits using proper AU identification format using the following electrical labeling color scheme:

- White letters on black for normal power. This is the standard identification for building systems and equipment.
- White letters on orange for critical power. This is for building systems and equipment (legally required) critical and optional emergency power.
- White letters on red. This is for life safety systems or emergency powered equipment only.

Submit panel directories in electronic form title by panel number. Install a printed copy of the panel schedule upon completion of the work. Include existing and new work. Handwritten panel schedules are not allowed.

ENERGY CONSERVATION

American University is committed to energy efficiency and conservation. Conformance with IECC requirements, NEMA premium motors, University efficiency initiatives and the minimum standards for energy conservation as set forth by the District of Columbia shall be exceeded, wherever possible.

DC Green Code 2013 requirements should be incorporated into the design. This includes switched receptacles symbol designation on the plate cover and utilize green colored receptacles and switches where available for classrooms, conference rooms, auditoriums, and common areas.

Metering, compatible with and integrated into the existing university collection and



software systems is required for new buildings. Sub-metering may be required for high load, billable or efficiency monitoring.

CALCULATIONS

All circuits shall be sized for the load to be served. Panel board schedules shall show the load on each circuit, as well as sizing calculations (including connected load, spare capacity and demand factors) used to calculate panel or switchboard size.

All power riser and one-line diagrams shall show the available short circuit currents at the service and each distribution point in the system. Switchboard and panel schedules shall indicate the available short circuit at the equipment.

On large projects where continuity of service is a critical issue, the Consultant shall provide the Owner with a selective coordination study. The study will show (using time current curves) the coordination among all main, feeder and branch circuit over current protection equipment.

The addition of equipment or circuits to a building emergency generator may require a load test to determine if capacity exists. Designer to submit power requirements to FM Master Electrician for review.

PRODUCT STANDARDS

All equipment and materials shall be certified as conforming to industry standards by a third-party laboratory service approved by the District of Columbia. These shall include but not be limited to the following:

- Underwriters Laboratories
- Electric Testing Laboratory
- National Electrical Manufacturers Association



- American National Standards Institute
- Certified Ballast Manufacturers
- Institute of Electrical and Electronic Engineers

All equipment and material shall bear the mark of the respective third-party laboratory service. Generally, provide NEMA 1 enclosures indoors and NEMA 3R enclosures outdoors.

ELECTRICAL DESIGN CRITERIA

GENERAL

All Electrical Work performed on campus must be permitted in accordance with DCRA requirements and under a DCRA provided Electrical Permit.

All projects on campus involving electrical work (regardless of voltage) shall be coordinated with the University's Master Electrician and AU's Commissioning Coordinator.

Projects performed under the Master Electrician's Operations and Maintenance permit shall not proceed from engineering to procurement and construction without the approval of AU's Master Electrician and Director of Energy and Engineering.

The Consultant shall coordinate with AU's Project Manager for specific information concerning those items and work to be provided under the Contract Documents.

Sources, Connections and Outages for Temporary Lighting and Power shall be coordinated with the AU's Master Electrician. Refer to Section 01 51 00 Temporary Utilities and sub-sections for Temporary Power and Temporary Lighting requirements.

Planning and Project Management (PPM) Division must pre-approve the placement of any equipment that will be visible from outside the facility.



The primary system is rated at 13, 200 volts, 3-phase wire. Additions to the system are installed and maintained by Facilities Management.

INSTALLATION OF ELECTRICAL SYSTEMS

Install wires and cables according to the NECA's "Standard of Installing" requirements.

Remove existing wire from raceway before pulling in new wire and cable.

Wiring at Outlets: Install at least 12 inches (300 mm) of slack conductor at each outlet.

Remove existing abandoned wiring & conduit designated as obsolete by AU authorities.

Firestop all penetrations through floors, walls and ceilings according to rating.

Outdoors Wiring Methods shall be as follows:

- Exposed: Rigid steel or intermediate metal conduit.
- Concealed: Rigid steel or Intermediate metal conduit or EMT
- Underground, Single Run: Rigid nonmetallic conduit.
- Underground, Grouped: Rigid nonmetallic conduit, concrete encased.
- Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid or Motor-Driven Equipment): Liquid-tight flexible metal conduit, not exceeding 24" length.

Indoors Wiring Methods (e.g. raceways) shall be as follows:

- Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid or Motor-Driven Equipment): Flexible metal conduit, except in wet or damp locations use liquid tight flexible metal conduit, not exceeding 24" length. Use conduit, tubing, or MC cable in applications allowed by NEC.
- Damp or Wet Locations: Rigid steel, PVC, or Intermediate metal conduit.
- Exposed (including unfinished interior spaces): Electrical metallic tubing, or Rigid



metallic conduit.

- Concealed: Electrical metallic tubing, rigid metallic conduit or MC cable except as otherwise indicated.
- Concealed Connections from JBox in Ceiling Space to Light Fixtures Not exceeding 6 feet length: MC cable, or flexible metal conduit.

Conceal wiring, unless otherwise indicated, within finished walls, ceilings, and floors.

Boxes and Enclosures: In damp or wet locations, use NEMA 250, Type 3, Type 4, stainless steel.

Use raceway fittings compatible with raceway and suitable for use and location. For intermediate steel conduit, use threaded rigid steel conduit fittings, unless otherwise indicated.

Raceways Embedded in Slabs: Install in middle third of the slab thickness where practical and leave at least 1-inch (25-mm) concrete cover.

Install exposed raceways parallel to and at right angles to nearby surfaces or structural members and follow the surface contours as much as practical.

Join raceways with fittings designed and approved for the purpose and make joints tight. Use bonding bushings or wedges at connections subject to vibration. Use insulating bushings to protect conductors.

Install pull wires in empty raceways. Use No. 14 AWG zinc-coated steel or monofilament plastic line having not less than 200-lb (90-kg) tensile strength. Leave not less than 12 inches (300 mm) of slack at each end of the pull wire.

Install raceway sealing fittings where required by the NEC and at wiring entrances to refrigerated spaces. Locate at suitable, approved, accessible locations and fill them with UL-listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces.



Stub-up Connections for Equipment: Extend conductors to equipment with [rigid steel] [intermediate metal] conduit; flexible metal conduit may be used 6 inches (150 mm) above the floor.

Install a separate green ground conductor in all raceways and conduits.

LOW VOLTAGE ELECTRICAL POWER AND CONDUCTORS - 26 05 19

All circuits abandoned or not used are to be located, identified, disconnected, and taken back to the source.

WIRES AND CABLES

Conductors: Copper.

Building Wires: Type THHN/THWN or XHHW, minimum conductor size #12 for branch circuits.

Armored Cable up to No.2 AWG: Type MC with green insulated copper ground conductor.

Cable No. 1 AWG and Larger: In conduit or EMT with green insulated copper ground conductor.

Connectors and Splices: Wiring connectors of size, ampacity rating, material, and type and class for application and for service indicated.

Single Conductor Plenum Coaxial: 75-ohm characteristic impedance, solid bare copper central conductor, foamed PTFE dielectric, 100 percent coverage copper, double-braid shield, PTFE jacket, suitable for installation in air-handling spaces.

Twisted-Pair Plenum: No. 24 AWG, 7-strand, copper conductors; PTF insulation; overall aluminum/polyester shield and No. 22 AWG copper drain wire; PTFE jacket; suitable for use in air-handling spaces.

GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS - 26 05 26

All electrical equipment, devices and raceways shall form a continuously grounded system. Neutral and ground shall be bonded only at the service entrance or at the secondary side of a separately derived system.



Every feeder and branch circuit raceway shall contain a green insulated copper equipment grounding conductor.

All emergency power systems shall be configured and grounded as separately derived systems.

Electrical boxes and enclosures shall be bonded to ground double locknuts and ground bushings.

Each wiring device shall be grounded by means of a separate code-size copper conductor connecting the device ground terminal to the branch circuit panel board ground bus. The conduit system shall not be relied upon for grounding.

HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS - 26 05 29

Lighting fixtures shall be tied (with tie wire) to deck above ceiling, supported at diagonal, opposing corners.

MINERALLAC STRAPS

Minerallac straps **ARE NOT ACCEPTABLE**; one-hole straps are acceptable

RACEWAYS AND BOXES FOR ELECTRICAL WORK - 26 05 33

RACEWAYS

Wire ways: Screwed cover type, with manufacturer's standard finish

Surface Metal Raceway Galvanized steel with Snap-On covers. Finish with manufacturer's standard prime coating suitable for painting.

Surface Nonmetallic Raceway: Two-piece construction, manufactured of rigid PVC compound with matte texture and manufacturer's standard color.

Outlet and Device Boxes: Sheet metal boxes, except use cast-metal boxes at exterior, interior exposed, and interior damp locations.



BOXES

Floor Boxes: Cast metal or Sheet metal, fully adjustable, rectangular

Pull and Junction Boxes: Sheet metal boxes, except use nonmetallic, cast aluminum or cast steel boxes with gasketed covers at exterior and interior damp locations.

UNDERGROUND DUCTS AND RACEWAYS - 26 05 43

AU does not permit Medium Voltage electrical distribution overhead or exposed on campus. All Medium Voltage electrical distribution systems shall be installed underground in duct banks.

All other electrical distribution shall be concealed in conduit or as otherwise approved.

No cabling shall be directly buried. The FM Project Manager shall coordinate actual routing and installation outside the buildings with AU's Master Electrician and Director of Energy & Engineering.

LOW VOLTAGE TRANSMISSION AND SERVICE - 26 21 00

Provide only one service entrance per building, except where otherwise specifically permitted by the Owner. Service entrance equipment shall be switchboard, panel board.

Overcurrent protection for the entire building shall be by single main device.

Service entrance switchboards shall have at least 20% spare breaker spaces, each fully provisioned and sized for estimated future loads.

Service entrance panel boards shall have at least 20% spare 3-pole spare breaker spaces, each fully provisioned and sized for one-half of estimated future loads.

If ground fault protection is provided on the main over current protection device, ground fault also shall be provided on devices in the same switchboard or panel board. All ground fault equipment shall be adjustable. (Initial settings shall be 20% of device rating, with 6-cycle time separation between main and feeder devices.)

Overcurrent protection, devices with ground fault will be circuit breaker only.



LOW-VOLTAGE TRANSFORMERS, DISTRIBUTION TRANSFORMERS 26 22XX

Transformers shall be the standard product of an approved transformer manufacturer. They shall be of live front, loop-feed configuration and pad-mounted design with voltage taps and a 4-position switch conforming to the Owner's standard specification.

DRY-TYPE TRANSFORMERS

Insulation shall be NEMA ST20 Standard for 220 degrees C. UL component recognized insulation system. For transformers rated 112.5 KVA and below, the insulation shall be rated 115 degrees C. rise above 40 degrees C. ambient. For transformers rated over 112.5 KVA, the insulation shall be rated 80 degrees C. rise above 40 degrees C. ambient.

Transformer enclosures shall be indoor-type, completely enclosed with drip-proof ventilated openings, steel with factory standard finish. Transformers less than 30 KVA three-phase or 25 KVA single-phase may have non-ventilated enclosures. Provide a concrete housekeeping pad, minimum 4" thick.

PRODUCTS

MANUFACTURED UNITS

General-Purpose, Dry-Type Transformers, 600 V or less:

- Comply with NEMA ST 20 and list and label as complying with UL 1561.
- Two winding type, three-phase units using one coil per phase in primary and secondary.
- Enclosure: Indoor, ventilated, Outdoor, ventilated, rain tight, NEMA 250, Type 3R.
- Wall-Mounting Brackets: Manufacturers standard for units up to 75 kVA.
- Taps: Standard; for transformers 25 kVA and smaller, provide 2 taps 5 percent below rated high voltage.

EXECUTION

INSTALLATION

Arrange equipment to provide adequate spacing for access and for cooling air
ELECTRICAL



circulation. Mount transformers larger than 75 kVA on concrete bases or 6" steel channels.

All wiring terminations are to be high-pressed type.

TESTING AND ADJUSTING

Perform visual and mechanical inspections and electrical tests stated in NETA ATS.

Adjust taps after installation to obtain indicated secondary voltage.

SWITCHBOARDS - 26 24 13

Motor branch circuits shall be 480-volt, three-phase, wherever possible. Provide disconnect switches near the motor and motor controller. Individual combination starters are not permitted. Motor control centers shall have combination starters.

All motor circuits shall be dedicated circuits, except for small fractional horsepower exhaust fans that can be easily served and controlled from local lighting and power circuits.

PANEL BOARDS - 26 24 16

REQUIREMENTS

Manufactures: Cutler-Hammer, General Electric, or Square-D
Flush and/or Surface mounted.

Load Capacity: Main breaker capacity and number of circuit breakers that panel will accommodate shall be made clear on Drawings.

Front: Shall be secured to box with concealed trim clamps or hinged to box with standard door within hinged cover.

Doors: Shall have concealed hinges, flush catches, and tumbler locks, all keyed alike.

Bus: Shall be hard drawn copper of 98 percent conductivity.



Molded-Case Circuit Breakers: NEMA AB 1, bolt-in, full module type. Single handle for multipole circuit breakers.

Fusible Switches: NEMA KS 1, Type HD, with [rejection] clips to accommodate indicated fuses, handle lockable.

Motor Controllers: NEMA ICS 2, Class A combination controllers.
Contactors: NEMA ICS 2, Class A combination contactors.

INSTALLATION

Install panel boards and accessory items according to NEMA PB 1.1. Indicate installed circuit locations on typed directory.

Mounting Heights: Top of trim 74 inches (1880 mm) above finished floor, unless otherwise indicated. Revise or delete paragraph below to suit Project.

Future Circuit Provisions at Flush Panel boards: Stub four empty 3/4-inch (19-mm) conduits from panel board into accessible or designated ceiling space and four empty conduits into raised floor or space below floor.

Wiring in Panel Board Gutters: Arrange conductors into groups bundle and wrap with wire ties.

Tighten electrical connectors and terminals, including grounding connections, according to manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A and UL486B.

Perform visual and mechanical inspections and electrical tests stated in NETA ATS.

MOTOR CONTROL CENTERS - 26 24 19

SECTION REQUIREMENTS

Submittals: Product Data.

Coordinate features of controllers and accessory devices with pilot devices and control circuits to which they connect.

Coordinate features, accessories, and functions of each motor controller with the
ELECTRICAL



ratings and characteristics of the supply circuit, the motor, the required control sequence, and the duty cycle of the motor and load.

PRODUCTS

CONTROLLERS AND ACCESSORIES

Manual Motor Controllers: NEMA ICS 2, general purpose, Class A with toggle action and overload element, in each phase. Hand-off-automatic switch and "on" pilot light in cover.

Magnetic Motor Controllers: NEMA ICS 2, Class A, full voltage, non-reversing, across the line, unless otherwise indicated; with integral control transformer. Hand-off-automatic switch and "on" pilot light in cover. Combination Controller: Factory-assembled combination controller and fusible disconnect switch.

Overload Relay: Ambient-compensated type with inverse-time-current characteristic. Provide heaters or sensors in each phase matched to nameplate full-load current of specific motor to which they connect, adjusted for duty cycle.

Multispeed-Motor Controller: Match controller to motor type, application, and number of speeds. Provide speed selector switch.

Reduced-Voltage Motor Controllers: Matching type of motor and load with appropriate (e.g. star-delta, part winding, other) type controller.

Pilot Lights and Selector Switches: NEMA ICS 2, heavy-duty typ.

All Motor Control Centers to have an electronic power meter.

Manufacturer: Electro Industries (Shark, or Nexus), factory installed and fully integrated with existing American University electricity collection equipment and software.

EXECUTION INSTALLATION

Use manual controllers for fractional-horsepower single-phase motors, unless otherwise indicated. Install independently mounted motor-control devices.



Install indicated fuses in each fusible switch.

Connect selector switches to bypass only the manual and automatic control devices that have no safety functions when switch is in the hand position.

Connect selector switches with motor-control circuit in both hand and automatic positions for safety-type control

Devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor overload protectors.

TESTING

Perform visual and mechanical inspections, and electrical tests stated in NETA ATS.

LOW-VOLTAGE DISTRIBUTION EQUIPMENT – 26 27 00

For new buildings, the power distribution system shall have separate life safety and emergency lighting. Power and mechanical loads shall have dedicated panel boards originating from the service entrance equipment.

WIRING DEVICES – 26 27 26

GENERAL SECTION

REQUIREMENTS

- Submittals: Product Data
- Comply with NEMA WD 1
- Comply with NEC

DEVICES

General: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction.

Color: Ivory unless otherwise indicated.

Receptacles: Heavy Duty grade, NEMA WD6, Configuration 5-20R unless otherwise
ELECTRICAL



indicated.

Ground-Fault Circuit Interrupter Receptacles: Feed-through type, with integral duplex receptacle; for installation in a 2-3/4-inch- (70-nuu-) deep outlet box without an adapter, Configuration 5-20R.

Transient Voltage Surge Suppressor Receptacles: Duplex type, with integral TVSS in line to ground, line to neutral, and neutral to ground; meets IEEE C62.41 Category B test with nominal transient-suppression clamp level of 500 V and minimum single transient pulse energy dissipation of 140 J line to neutral, and 70 J line to ground and neutral to ground.

Snap Switches: Heavy-duty, quiet type, 277 Volts rated.

Incandescent Lamp Dimmers: Modular, 120 V, 60Hz with audible and electromagnetic noise filters and continuously adjustable slide, single pole with soft tap or other quiet switch, min. 600 Volts rated.

Fluorescent Lamp Dimmers: Modular, compatible with dimmer ballasts, with audible and electromagnetic noise filters and capable of consistent dimming to a maximum of 10 percent full brightness. Include trim potentiometer.

Dimming System: Factory assembled dimming/relay panel, NEMA 1 grade, and low voltage control stations and interface panel. Dimmers to provide a smooth and continuous "square law" dimming curve throughout the entire dimming range. Dimming ballasts will be provided with the fixtures.

Wall Plates, Finished Areas: Satin-finish stainless steel, fastened with metal screws having heads matching plate color. Provide standard-size Type 304 stainless steel wall plates that are compatible with the switches. Provide Stainless steel screws for securing the devices to the wall plates.

Wall Plates, Unfinished Areas: Satin-finish stainless steel with metal screws.

Floor Service Fittings: Modular, above-floor, dual-service units suitable for wiring method used.

Multi-outlet Assemblies: Components produced by a single manufacturer designed for use as a complete, matching assembly of raceways and receptacles. Metallic



raceway with No. 12 AWG wire. One receptacle per 12 inches (300 mm).

AUTOMATIC WALL SWITCH shall:

- be Manufactured by Novitas or Watt Stopper
- be Ivory-colored, decorator-style, low profile, UL-listed automatic light switch which replaces and fits into a single-gang wall switch outlet box.
- have the following features:
 - 277-volt AC, manual-on, 60 to 1200 watt (ballast load), single level lighting control with 180- degree coverage for 900 (maximum) square feet.
 - Digital time-delay adjustable covering at least the interval from 90-seconds to 30-minutes.
 - Adjustable unit sensitivity from 20-percent to 100-percent.
 - Integrated Light Level Sensor.
 - LED for sensitivity calibration.
 - Compatible with electronic ballasts.

CEILING-MOUNTED ULTRA-SONIC DETECTORS shall:

- White-colored, 24-volt, AC, 20-milliampere, UL-listed sensor for use with companion relay/power supply.
- Configured where the ultrasonic signals of one sensor can interfere with the operation of an adjacent unit; provide detector units with different operating frequencies.
- Have the following features:
 - 360-degree single-directional, 1000 square-foot coverage.
 - Temperature and humidity resistant solid-state, crystal-controlled 25-kilo-hertz detector.
 - Logic Key/On by-pass.
 - Adjustable time delay covering at least 30-seconds to 12-minutes.
 - Adjustable sensitivity

DUAL TECHNOLOGY OCCUPANCY SENSORS shall:

- White-colored, 24 VDC, 28-milliampere, UL and CUL listed for use with power pack.
- Have the following features:
 - PIR and Ultrasonic technologies



- Integrated light level sensor 2.5 to 430 foot coverage
- Single pole, double-throw isolated relay
- 40kHz +/- 0.006% frequency ultrasonic
- Adjustable time-delay of 15 sec. to 15 min.
- LED indicator for both technologies
- Adjustable sensitivity

COMBINATION RELAY/POWER SUPPLY shall:

- Junction box mounted, UL-listed, 277-volt primary, 24-volt DC secondary, 100-milliampere secondary, Self-contained transformer/relay unit.
- Have relay contacts rated 277-volts, shall open when the room is unoccupied, and close when the room is occupied.

WALL PLATES

- a. Where unit sensor and manual wall switch are located side-by-side, provide common wall plate and barrier switchbox.
- b. Where wall plate cover is not specifically listed, cover to be stainless.

INSTALLATION

- Install devices and assemblies' plumb and secure.
- Mount devices flush, with long dimension vertical, and grounding terminal of receptacles on top unless otherwise indicated. Group adjacent devices under single, multigang wall plates.
- Protect devices and assemblies during painting.
- Install wall plates when painting is complete.
- Install wall-mounted devices vertically and in accordance with NEC and recognized industry practices. Mounting heights shall be as noted on the contract Drawings for switches. Ceiling-mount sensors to back plates secured to ceilings.
- Where automatic wall switches are shown adjacent to wall switches, the automatic switch (indicated as OS) shall be connected to control all of the lighting in the room. The manual switch shall be connected between the output leg of the occupancy sensor switch and the switched leg to the outside-lamp ballasts and act as an override-to-off switch. The inside lamp ballasts shall be connected directly to the output of the occupancy sensor.
- In rooms with ceiling-mounted occupancy sensors (indicated as OSI) and sus-



pendent ceilings, surface mount the occupancy sensors to the center of ceiling tiles. Connect the power supply/relay unit to the normal power source and connect the relay contacts in series with the line side of both wall switches for the in- side and outside lamp ballasts. The switches shall act as "override-to-off."

- Wiring from ceiling-mounted sensors to relay/power supplies shall be with plenum-rated, limited-energy, three-conductor, and #18 through #22 copper conductors. Coordinate with other work, including ceiling installation, painting, wiring and box installation. Notify the Owner's Representative of location discrepancies before roughing-in device and then obtain a new location as necessary.
- Wall-mounted devices shall be installed after wiring is complete.
- Install cover-plates and devices after painting is complete.
- Install wall-mounted devices and combination relay/power supplies to electrical boxes which are clean and free of building material, dirt and debris
- Provide electrically continuous, tight ground connections for the automatic switches.
- Ground the hex green grounding screw of the switching device to the ground wire of the branch circuit.

TESTING

- Test all automatic switches and all sensors for proper operation. Adjust sensitivity and time-delay of all sensors and demonstrate adjustment and operating procedures to Owner.

LOW-VOLTAGE CIRCUIT PROTECTIVE DEVICES – 26 28 00

ENCLOSURES

- a. Hinged-Cover Enclosures: NEMA 250, steel enclosure with continuous hinge cover and flush latch. Finish inside and out with manufacturer's standard enamel.
- b. Cabinets: NEMA 250, Type 1, unless otherwise indicated.

CIRCUIT BREAKERS - 26 28 16

- Manufacturer: Cutler-Hammer, General Electric, or Square-D
- Enclosed, Molded-Case Circuit Breaker: NEMA AB 1, with lockable handle and thermal-magnetic trip unless otherwise indicated.
 - Characteristics: Frame size, trip rating, number of poles, and auxiliary de-



vices as indicated.

- Interrupting Rating: Exceeds available fault current.
- Thermal-Magnetic Circuit Breakers, 225 A and Larger: Trip units [interchangeable within frame size] [with adjustable magnetic trip].
- Electronic Trip Unit Circuit Breakers, 400A and Larger: Field-adjustable, short time and continuous-current [and ground-fault trip] settings.
- Current-Limiting Trips: Let-through ratings less than NEMA FU 1, Class RK-5.
- Enclosure: NEMA AB 1, Type 1, unless otherwise specified or required to meet environmental conditions of installed location.
- Circuit breaker to be bolt-in type.
- Perform visual and mechanical inspections and electrical tests stated in NETA ATS.

ENCLOSED SWITCHES - 26 28 16.16

Enclosed, Non-fusible Switch: NEMA KS 1, Type HD, with lockable handle.
Enclosed, Fusible Switch, 800 A and Smaller: NEMA KS 1, Type HD, clips to accommodate specified fuses, enclosure consistent with environment where located, handle lockable with 2 padlocks, and interlocked with cover in closed position.

LIGHTING – 26 50 00

Refer to the detailed recommendation standard develop by AU to meet efficiency goals and maintenance standards for LED Lighting 26 5522.

LIGHTING BRANCH CIRCUITS

- Wherever possible, lighting branch circuits shall be 277-volt, single-phase. When 120/208 voltages are used, provide separate circuits for lighting loads only.
- Lighting branch circuits may be arranged as three-phase conductors, one neutral conductor and one grounding conductor for each home run.

INSTALLATION

- Set units, level, plumb, and square with ceiling and walls, and secure.
- Support for Recessed and Semi-recessed Grid-Type Fluorescent Fixtures: Install ceiling support system rods or wires at a minimum of 2 rods or wires for



each fixture, located not more than 6 inches (150 mm) from fixture corners.

- Support for Suspended Fixtures: Brace pendants and rods over 48 inches (1220 mm) long to limit swinging. Support stem-mounted, single-unit, suspended fluorescent fixtures with twin-stem hangers. For continuous rows, use tubing or stem for wiring at one point and tubing or rod for suspension for each unit length of chassis, including one at each end.
- Lamping: Where specific lamp designations are not indicated, lamp units according to manufacturer's written instructions.
- Air Handling Fixtures: Install with dampers closed.

INTERIOR LIGHTING - 26 51 00

The Designer shall match existing fixtures and luminaires currently in use on campus where possible. This assists in repair and response time.

MER's shall be well lit with LED lighting and be switched at each exit. All mechanical equipment rooms shall be equipped with duplex convenience outlets suitable for operating small tools and drop-cord trouble lights.

INTERIOR FIXTURES, LAMPS AND BALLASTS - 26 51 13

Submittals: Product Data for each luminaire, including lamps.

- Fixtures, Emergency Lighting Units, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction.
- Coordinate ceiling-mounted luminaires with ceiling construction, mechanical work, and security and fire-prevention features mounted in ceiling space and on ceiling.

GENERAL

- Metal Parts: Free from burrs, sharp corners, and edges. Steel, unless otherwise indicated. Form and support to prevent warping and sagging.
- Doors, Frames, and Other Internal Access: Smooth operating, free from light leakage under operating conditions, and arranged to permit re-lamping without use of tools. Arrange doors, frames, lenses, diffusers, and other pieces to prevent accidental falling during re-lamping and when secured in operating position.



- Lenses, Diffusers, Covers, and Globes: 100 percent virgin acrylic plastic or annealed crystal glass, unless otherwise indicated.
- Lighting fixtures shall be selected and designed to meet requirements of ASHRAE Standard 90.1-2010 for lighting power densities (in watts per square foot) and in accordance with the recommendations of the Illuminating Engineering Society of North America (IESNA). Lighting design levels should not exceed power density or IES standards. These standards are readily available and take into account the type of visual activity in a space, and the age range of the users of the space.
- Incandescent lamps are prohibited unless explicitly approved by the university. Suitable replacements can usually be found among the many varieties of compact fluorescent lamps. Varieties are now available which approach the color of incandescent light.
- Use electronic ballasts and T8 lamps in fluorescent light fixtures. They combine the best quality of light with the most energy savings.
- Not all electronic ballasts, light fixtures and controls are created equal. Compare manufacturer's warranties and include required information for Owner to maximize warranty.
- Occupancy sensors should be considered where spaces are occupied intermittently. They can be inexpensively installed in individual offices, classrooms, and small to moderate size conference rooms.
- Lighting design shall emphasize accessibility for re-lamping, cleaning and maintenance. The location of fixtures over hazardous chemicals, mechanical equipment and laboratory benches shall be avoided. Special provisions shall be made for lamps located in high ceiling areas for lowering or otherwise solving the maintenance problem.

LUMINAIRES

Fixture Type: Designer shall provide a fixture schedule with a description of manufacturers and model numbers.

Life safety exit and night lighting fixtures shall not be equipped with switches. All other light fixtures shall be switched or controlled. Office, conference and other administrative or presentation spaces shall have dual-level switching.

Source low-mercury lamps for indoor and outdoor fixtures as well as both hard-wired and portable fixtures. Mercury-containing lamps shall contain no more than 90 picograms per lumen hour, with a target of 70 picograms per lumen hour or less where available. Where less than 90 picograms per lumen hours is unavoidable, using an



across the building or project calculation may be acceptable, code permitting.

CFLs should comply with the voluntary industry guidelines for maximum mercury content published by the National Electrical Manufacturers Association (NEMA).

EMERGENCY LIGHTING – 26 52 00

- Life safety power circuits shall include fire alarm, warning systems and emergency communication systems.
- Life safety lighting circuits shall include emergency exit lighting and exit signs. An emergency generator shall provide backup power.
- In facilities with emergency generators, provide separate dedicated wiring circuits.
- Light fixtures with in-fixture battery/inverter packages shall be prominently marked.
- Life safety exit and night lighting fixtures shall not be equipped with switches.

EXIT SIGNS – 26 53 00

- Exit signs are LED.
- General Requirements – Comply with UL 924 and the following:
- Self-Powered Exit Signs (Battery Type): Integral automatic charger in a self-contained power pack. Sealed, maintenance-free, nickel-cadmium battery and fully automatic, solid-state charger with sealed transfer relay.
- Manufacturer: Lithonia Lighting
- Model: LX W 3 R EL N
- Sign material: Steel
- Sign colors: White single stencil, red lettering
- Lettering Size: $\frac{3}{4}$ " stroke X 6" high.

EXTERIOR LIGHTING - 26 56 00

- Reference the AU Lighting Master Plan,
- New construction may include some outside area lighting for landscape and security. All street and parking lot lighting, including fixture selection, and placement will be approved by the Project Manager, AU's Master Electrician and a representative from University Safety and Security Services. Designer should match existing parking lot light, emergency phone poles, and exterior building lighting to current campus fixtures.



- To make utility connections, the Project Manager will schedule all interruptions of services.
- Walkway lights are Spring City “Washington Standard” LED. Color Temperature shall be 5,000 Kelvin.
- Site lighting circuits shall be served by PVC conduit with THHN/THWN copper wire.
- Circuits shall be buried a minimum of 18 inches deep.
- Poles and fixtures shall be grounded.
- Building entrances, walkways and parking areas shall be properly illuminated for safety and security. Exterior lighting fixtures shall utilize the American University standard fixture to the extent possible on the Campus grounds. Small exterior auxiliary or service spaces may be illuminated with fluorescent fixtures equipped with cold weather ballasts.
- Exterior light fixtures shall be selected to avoid light pollution, including shielded and low wattage fixtures as per LEED and code requirements
- Separate circuits controlled by a photocell shall serve exterior and site lighting fixtures. Parking lot and other area lighting fixtures shall be circuited separately from stairway, porch or canopy lights; however, the same photocell may control both kinds of lighting.

DIVISION 26 ELECTRICAL PRODUCTS AND MANUFACTURERS

Subject to compliance with project requirements, basis-of-design manufacturer(s) (and model number if applicable) shall be:

Concrete Vaults – Electrical

1. S&C Electric Trenwa

Emergency Generator

2. Cummins w/ matching AFS

Imbiber Beads

3. Inhibitive Technologies

Metering Device – Main Distribution

4. Nexus 1500

Metering Device - Sub meter

5. Nexus Shark

Transfer Switch

6. Cummings Power Transformer – Medium Voltage

Howard Underground Switchgear

7. S&C Electric Vistas



Subject to compliance with project requirements, acceptable manufacture(s) include, but are not limited to the following:

Automatic Wall Switch

1. Wattstopper

Circuit Breakers

1. Cutler Hammer

General Electric

1. Square D

Dimmer Controls

1. Lutron
2. N-Light

Dimmer Switch

1. Bryant
2. Pass & Seymour

Electric Service Switch

1. Cutler Hammer
2. Siemens
3. Square D

Electric Panels

1. Cutler Hammer
2. Siemens
3. Square D
4. Westinghouse

Motor Control Center

1. General Electric
2. Siemens
3. Westinghouse

Panel Boards

1. Cutler Hammer
2. General Electric
3. Square D

Transformer

1. Siemens
2. Square D
3. Westinghouse

26 32 1x GENERATORS

PART 1 - GENERAL

SCOPE

- A. Provide complete factory assembled generator set equipment with digital (microprocessor-based) electronic generator set controls, digital governor, digital voltage regulator, and all auxiliary systems required for automatic operation.
- B. Provide factory testing, on-site startup and on-site testing of the system by a supplier authorized by the equipment manufacturer.
- C. The generator set manufacturer shall warrant all equipment provided under this section, so that there is one source for warranty and product service. Technicians specifically trained and certified by the manufacturer to support the product and employed by the generator set supplier shall service the generator set.

CODES AND STANDARDS

The generator set installation and on-site testing shall conform to the requirements of the following codes and standards, as applicable.

- A. The generator set shall include necessary features to meet the requirements of these standards.
 - i. IEEE 446 - recommended practice for emergency and standby power systems for commercial and industrial applications.
 - ii. NFPA 37 standard for the installation and use of stationary combustion engines and gas turbines.
 - iii. NFPA 70 - national electrical code. Equipment shall be suitable for use in systems in compliance to articles 700, 701, and 702.
 - iv. NFPA 110 emergency and standby power systems. The generator set shall meet all requirements for level 1 systems. Level 1 prototype tests required by this standard shall have been performed on a complete and functional unit. Component level type tests will not be allowed to substitute for this requirement.
- B. The generator set and supplied accessories shall meet the requirements of the following standards:
 - i. NEMA publication mg1, part 32 - the alternator shall comply with the requirements of this standard.
 - ii. UL1236 - battery charger.
 - iii. UL 2200 - the generator set shall be listed under UL 2200 or submit evidence of an independent third party certification process to verify compliance as furnished.
 - iv. Diesel and gas engines shall be EPA tier 3 certified all engines diesel or gas shall include a valid EPA engine certificate of compliance.

- C. The control system for the generator set shall comply with the following requirements:
- i. En 50082-2, electromagnetic compatibility generic immunity requirements, part 2: industrial.
 - ii. En 55011 limits and methods of measurement of radio interference characteristics of industrial, scientific and medical equipment
 - iii. FCC part 15, subpart b.
 - iv. IEC 8528, part 4 - control systems for generator sets.
 - v. IEC std 801.2, 801.3, and 801.5 for susceptibility, conducted, and radiated electromagnetic emissions.
 - vi. UL 508 - the entire control system of the generator set shall be UL 508 listed and labeled.
 - vii. UL 1236 - battery chargers.
- D. The generator set manufacturer shall be certified to iso 9001 international quality standard and shall have third party certification VERIFYING QUALITY ASSURANCE IN design/development, production, installation, and service, in accordance with iso 9001.

ACCEPTABLE MANUFACTURER

- A. Manufacturer shall be Cummins power generation, no substitutes.

SUBMITTALS

Submittals shall be clear and legible and shall include the following

A. Design Review

- i. Submit three copies of each shop drawing.
- ii. A maximum of two marked copies will be returned to the manufacturer, or one additional reproducible copy may be submitted to be marked and returned for manufacturer's use.
- iii. Identify each item submitted using applicable specification section number and paragraph reference.
- iv. Manufacturer's product literature and performance data, sufficient to verify compliance to specification requirements.
- v. Maintenance requirements.
- vi. Warranty with copy of manufacturer and/or component requirements.
- vii. Manufacturer's certification of prototype testing.
- viii. Manufacturer's installation instructions.

B. O&M Submission.

- C. Manufacturer's emergency power system operating and maintenance instruction manuals.

- D. Operating and maintenance instruction manuals covering the entire emergency power system including the transfer scheme.
- E. Framed operating instructions shall be mounted on or near the unit.
- F. Executed warranty documents.
- G. Shop drawings showing plan and elevation views with certified overall dimensions, as well as wiring interconnection details.
- H. Interconnection wiring diagrams showing all external connections required, with field wiring terminals marked in a consistent point-to-point manner.

SERVICE AND SUPPORT

- A. The manufacturer of the generator set shall maintain service parts inventory at a central location that is accessible to the service location 24 hours per day, 365 days per year.
- B. The generator set shall be serviced by a local service organization that is trained and factory certified in generator set service. The supplier shall maintain an inventory of critical replacement parts at the local service organization, and in service vehicles. The service organization shall be on call 24 hours per day, 365 days per year.
- C. The manufacturer shall maintain model and serial number records of generator set provided for at least 20 years.

WARRANTY

- A. The generator set and associated equipment shall be warranted for a period of not less than 5 years or 1500 hours from the date of commissioning against defects in materials and workmanship.
- B. The warranty shall be comprehensive. No deductibles will be allowed for travel time, service hours, repair parts cost, etc.

TRAINING:

- A. The equipment supplier shall provide training for the facility operating personnel covering operation and maintenance of the equipment provided.
- B. The training program shall be not less than 4 hours in duration, the class size shall be limited to 5 persons, and the training shall occur at the owner's site.
- C. The training shall be videotaped.
- D. Training date shall be coordinated with the facility owner through commissioning.

PART 2 - PRODUCT REQUIREMENTS

GENERATOR SET

A. RATINGS

- i. The generator set shall operate at project design voltage at 1800 rpm and shall be three phase, 4 wire and 60 hertz.
- ii. The generator set shall be sized for project load (kwh), operating at 0.8 pf, standby rated, based on site conditions of: altitude 1000 ft., and ambient temperatures up to 104 degrees F. These ratings shall be increased if necessary, to carry full continuous and motor starting loads of the actual equipment provided. Any other changes necessitated by a change in generator capacity shall also be made.
- iii. The generator set rating shall be based on emergency service.

B. PERFORMANCE

- i. Voltage regulation shall be plus or minus 0.5 percent for any constant load between no load and rated load. Random voltage variation with any steady load from no load to full load shall not exceed plus or minus 0.5 percent.
- ii. Frequency regulation shall be isochronous from steady state no load to steady state rated load. Random frequency variation with any steady load from no load to full load shall not exceed plus or minus 0.5 percent.
- iii. The diesel engine-generator set shall accept a single step load of 100 percent nameplate kW and power factor, less applicable derating factors, with the engine-generator set at operating temperature.
- iv. Motor starting capability shall be a minimum of 105% of design load.
- v. The generator set shall be capable of recovering to a minimum of 90 percent of rated no load voltage following the application of the specified kva load at near zero power factor applied to the generator set. Maximum voltage dip on application of this load, considering both alternator performance and engine speed changes shall not exceed 15 percent.
- vi. The alternator shall produce a clean ac voltage waveform, with not more than 5 percent total harmonic distortion at full linear load, when measured from line to neutral, and with not more than 3 percent in any single harmonic, and no third order harmonics or their multiples. Telephone influence factor shall be less than 40.
- vii. The generator set manufacturer to be shall be certified by the engine suitable for use at the installed location and rating and shall meet all applicable exhaust emission requirements at the time of commissioning.

C. CONSTRUCTION

- i. The engine-generator set shall be mounted on a heavy-duty steel base to maintain alignment between components. The base shall incorporate a battery tray with hold-down clamps within the rails.
- ii. All switches, lamps, and meters in the control system shall be oil-tight and

dust tight. All active control components shall be installed within a UL/NEMA 3r enclosure. There shall be no exposed points in the control enclosure (with the door open) that operate in excess of 50 volts.

D. CONNECTIONS

- i. The generator set load connections shall be composed of silver or tin plated copper bus bars, drilled to accept mechanical terminations. Sufficient lug space shall be provided for use with cables of the number and size as shown in the drawings.
- ii. Power connections to auxiliary devices shall be made at the devices, with required protection located at a wall-mounted common distribution panel.
- iii. Generator set control interfaces to other system components shall be assembly. Made on a permanently labeled labels describing connection terminal block point functions shall be provided.

ENGINE AND ENGINE EQUIPMENT

- A. The engine shall be diesel, 4 cycle, radiator and fan cooled. Minimum displacement shall be 661 cubic inches (10.8 liters), with 6 cylinders. The horsepower rating of the engine at its minimum tolerance level shall be sufficient to drive the alternator and all connected accessories. Two cycle engines are not acceptable.
- B. Generator exhaust should be ducted to discharge above the roof at a location remote from any air intakes. In special applications, exhaust discharge can be located at ground level in a protected manhole away from pedestrian traffic.
- C. Fuel oil tanks for emergency generators shall be mounted above ground.
- D. Engine accessories and features shall include:
 - i. An electronic governor system shall provide automatic isochronous frequency regulation.
 - ii. The control system shall actively control the fuel rate and excitation as appropriate to the state of the generator set. Fuel rate shall be regulated as a function of starting, accelerating to start disconnect speed, and accelerating to rated speed.
 - iii. The governing system shall include a programmable warm up at idle and cool down at idle function. While operating in an idle state, the control system shall disable the alternator excitation system.
 - iv. Skid-mounted radiator and cooling system rated for full load operation in 122 degrees f ambient as measured at the alternator air inlet.
 - v. Radiator fan shall be suitable for use in a system with 0.5-inch h₂O static restriction. Radiator shall be sized based on a core temperature that is 20 degrees f higher than the rated operation temperature, or prototype tested to verify cooling performance of the engine/radiator/ fan operation in a controlled environment.
 - vi. The radiator shall be provided with a duct adapter flange. The equipment manufacturer shall fill the cooling system with a 50/50 ethylene glycol/water

- mixture prior to shipping. Rotating parts shall be guarded against accidental contact.
- vii. The electric starter shall be capable of three complete cranking cycles without overheating.
 - viii. Lubrication oil pump shall be positive displacement, mechanical, full pressure type.
 - ix. Lubrication oil filters shall be full flow type with replaceable spin-on canister elements and dipstick oil level indicator.
 - x. Fuel pump shall be an engine driven, mechanical, positive displacement type.
 - xi. Fuel filter shall include a replaceable spin- on canister element.
 - xii. A fuel cooler, suitable for operation of the generator set at full rated load in the ambient temperature specified, shall be provided if required for operation due to the design of the engine and the installation.
 - xiii. Air filter shall be replaceable dry element type with restriction indicator.
 - xiv. Supply and return fuel lines shall be flexible type.
 - xv. The engine mounted battery charging alternator shall be 40-ampere minimum, with solid-state voltage regulator.
 - xvi. Coolant heater
 - xvii. Provide engine mounted thermostatically controlled, coolant heater for engine. The heater voltage shall be 208 volts, single phase.
 - xviii. The coolant heater shall be ul 499 listed and labeled.
 - xix. The coolant heater shall be installed on the engine with silicone hose connections. Steel tubing shall be used for connections into the engine coolant system wherever the length of pipe run exceeds 12 inches. The coolant heater installation shall be specifically designed to provide proper venting of the system. The coolant heaters shall include provisions to isolate the heater for replacement of the heater element without draining the coolant from the generator set. Quick disconnect/automatic sealing couplers shall allow the heater element to be replaced without draining the engine cooling system or significant coolant loss.
 - xx. The coolant heater shall be provided with a dc thermostat, installed at the engine thermostat housing. An ac power connection box shall be provided for a single ac power connection to the coolant heater system.
 - xxi. The coolant heater(s) shall be sized as recommended by the engine manufacturer to warm the engine to a minimum of 104 degrees f in a 40 degrees f ambient, in compliance with NFPA 110 requirements, or the temperature required for starting and load pickup requirements of this specification.
 - xxii. Provide vibration isolators as recommended by the generator set manufacturer. Isolators shall include seismic restraints if required by site location.
 - xxiii. Starting and control batteries shall be lead acid type, 24-volt dc, sized as recommended by the engine manufacturer, complete with battery cables and connectors. The batteries shall be capable of a minimum of three complete 15-second cranking cycles at 40 degrees f ambient temperature when fully charged.
 - xxiv. Provide critical grade exhaust silencer for engine of size and type as recommended by the generator set manufacturer and approved by the engine

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Design Standards

- xxv. manufacturer. The exhaust system shall be installed inside the genset enclosure according to the engine manufacturer's recommendations and applicable codes and standards.
- xxvi. Exhaust system shall include a minimum 18 inch long flexible steel exhaust connection for each
- xxvii. Exhaust outlet to silencer.
 - a. Exhaust silencer shall reduce noise 25-35 decibels as compared to the generator's open exhaust.
 - b. Provide a threaded drain hole.
- xxviii. Provide an ul listed 10-amp voltage regulated battery charger. The charger may be located in the automatic transfer switch, or may be wall mounted, at the discretion of the installer. Input ac voltage and dc output voltage shall be as required. The charger shall be equipped with float, taper and equalize charge settings. Operational monitors shall provide visual output along with individual form c contacts rated at 4 amps, 120 volts ac, 30 volts dc for remote indication of:
 - a. Loss of ac power - red light.
 - b. Low battery voltage - red light.
 - c. High battery voltage - red light.
 - d. Power on - green light (no relay contact).
- xxix. Charger shall include an analog dc voltmeter and ammeter, 12 hour equalize charge timer, and ac and dc fuses.

AC GENERATOR

- A. The ac generator shall be: synchronous, four pole, 2/3-pitch, revolving field, drip-proof construction, single pre-lubricated sealed bearing, air cooled by a direct drive centrifugal blower fan, and directly connected to the engine with flexible drive disc. All insulation system components shall meet NEMA mg1 temperature limits for class h insulation system and shall be ul 1446 listed. The actual temperature rise measured by resistance method at full load shall not exceed 105 degrees centigrade.
- B. The generator shall be capable of delivering rated output (kva) at rated frequency and power factor, at any voltage not more than 5 percent above or below rated voltage.
- C. A permanent magnet generator (pmg) shall be included to provide a reliable source of excitation power for optimum motor starting and short circuit performance. The pmg and controls shall be capable of sustaining and regulating current supplied to a single phase or three phase fault at approximately 300 percent of rated current for not more than 10 seconds.
- D. The sub transient reactance of the alternator shall not exceed 12 percent, based on the standby rating of the generator set.

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GENERATOR SET CONTROL

- A. The generator set shall be provided with a microprocessor-based control system that is designed to provide automatic starting, monitoring, and control functions for the generator set. The control system shall also be designed to allow local monitoring and control of the generator set, and remote monitoring and control as described in this specification.
- B. The control shall be mounted on the generator set. The control shall be vibration isolated and prototype tested to verify the durability of all components in the system under the vibration conditions encountered.
- C. The generator set mounted control shall include the following features and functions:
- a. Control switches
 - i. Mode select switch: the mode select switch shall initiate the following control modes. When in the run or manual position the generator set shall start and accelerate to rated speed and voltage as directed by the operator. A separate push-button to initiate starting is acceptable. In the off position the generator set shall immediately stop, bypassing all time delays. In the auto position, the generator set shall be ready to accept a signal from a remote device to start and accelerate to rated speed and voltage.
 - ii. Emergency stop switch: switch shall be red "mushroom-head" push-button. Depressing the emergency stop switch shall cause the generator set to immediately shut down and be locked out from automatic restarting.
 - iii. Reset switch: the reset switch shall be used to clear a fault and allow restarting the generator set after it has shut down for any fault condition.
 - iv. Panel lamp switch: depressing the panel lamp switch shall cause the entire panel to be lighted with dc control power. The panel lamps shall automatically be switched off 10 minutes after the switch is depressed, or after the switch is depressed a second time.
 - b. Generator set ac output metering: the generator set shall be provided with a metering set including the following features and functions:
 - i. Digital metering set, 1 percent accuracy, to indicate generator rms voltage and current, frequency, output current, output kw, kwh, and power factor. The generator output voltage shall be available in line-to-line and line- to-neutral voltages and shall display all three-phase voltages (line to neutral or line-to-line) simultaneously.
 - ii. The control system shall monitor the total load on the generator set and maintain data logs of total operating hours at specific load levels ranging from 0 to 100 percent of rated load, in 10 percent increments. The control shall display hours of operation at less than 30 percent load and total hours of operation at more than 90 percent of rated load.
 - iii. The control system shall log the total number of operating hours, total kWh, and total control on hours, as well as total values since reset.

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- c. Generator set alarm and status display
 - i. The generator set control shall include led alarm and status indication lamps. The lamps shall be high intensity led type. The lamp condition shall be clearly apparent under bright room lighting conditions. Functions indicated by the lamps shall include:
 - i. The control shall include five configurable alarm-indicating lamps. The lamps shall be field adjustable for any status, warning, or shutdown function monitored by the genset. They shall also be configurable for color, and control action (status, warning, or shutdown).
 - ii. The control shall include green lamps to indicate that the generator set is running at rated frequency and voltage, and that a remote start signal has been received at the generator set. The running signal shall be based on actual sensed voltage and frequency on the output terminals of the generator set.
 - iv. The control shall include a flashing red lamp to indicate that the control is not in automatic state, and red common shutdown lamp.
 - v. The control shall include an amber common warning indication lamp.
- d. The generator set control
 - i. Shall indicate the existence of the warning and shutdown conditions on the control panel. All conditions indicated below for warning shall be field-configurable for shutdown. Conditions required to be annunciated shall include:
 - 1. Low oil pressure (warning)
 - 2. Low oil pressure (shutdown)
 - 3. Oil pressure sender failure (warning)
 - 4. Low coolant temperature (warning)
 - 5. High coolant temperature (warning)
 - 6. High coolant temperature (shutdown)
 - 7. High oil temperature (warning)
 - 8. Engine temperature sender failure (warning)
 - 9. Low coolant level (warning)
 - 10. Fail to crank (shutdown)
 - 11. Fail to start/over crank (shutdown)
 - 12. Over speed (shutdown)
 - 13. Low dc voltage (warning)
 - 14. High dc voltage (warning)
 - 15. Weak battery (warning)
 - 16. Low fuel (warning)
 - 17. High ac voltage (shutdown)
 - 18. Low ac voltage (shutdown)
 - 19. Under frequency (shutdown)
 - 20. Over current (warning)
 - 21. Over current (shutdown)
 - 22. Short circuit (shutdown)
 - 23. Overload (warning)
 - 24. Emergency stop (shutdown)
- e. Four (4) configurable conditions

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- f. Provisions shall be made for indication of 4 customer-specified alarm or shutdown conditions. Labeling of the customer-specified alarm or shutdown conditions shall be of the same type and quality as the above-specified conditions. The non-automatic indicating lamp shall be red and shall flash to indicate that the generator set is not able to automatically respond to a command to start from a remote location.

ENGINE STATUS MONITORING

- A. The following information shall be available from a digital status panel on the generator set control:
 - i. Engine oil pressure (psi)
 - ii. Engine coolant temperature (degrees f)
 - iii. Engine oil temperature (degrees f)
 - iv. Engine speed (rpm)
 - v. Number of hours of operation (hours)
 - vi. Number of start attempts
 - vii. Battery voltage (dc volts)
 - viii. The control system shall also incorporate a data logging and display provision to allow logging of the last 10 warning or shutdown indications on the generator set, as well as total time of operation at various loads, as a percent of the standby rating of the generator set.

Engine control functions

- A. The control system provided shall include a cycle cranking system, which allows for user selected crank time, rest time, and number of cycles. Initial settings shall be for cranking periods of 15 seconds each, with 15-second rest period between cranking periods.
- B. The control system shall include an idle mode control, which allows the engine to run in idle mode in the run position only. In this mode, the alternator excitation system shall be disabled.
- C. The control system shall include an engine governor control, which functions to provide steady state frequency regulation as noted elsewhere in this specification. The governor control shall include adjustments for gain, damping, and a ramping function to control engine speed and limit exhaust smoke while the unit is starting.
- D. The control system shall include time delay start (adjustable 0-300 seconds) and time delay stop (adjustable 0-600 seconds) functions.
- E. The control system shall include sender failure monitoring logic for speed sensing, oil pressure, and engine temperature which is capable of discriminating between failed sender or wiring components, and an actual failure condition.
- F. The control system shall be equipped with dry contacts that receive power from the battery system and that are controlled to provide 24-volt output to a solenoid valve in

the fuel oil supply line from the fuel oil tank. Contacts shall provide power to energize and open the solenoid valve and allow fuel oil flow when generator receives start signal and remove power to de-energize the solenoid valve to stop fuel oil flow when generator shuts down.

ALTERNATOR CONTROL FUNCTIONS

- A. The generator set shall include an automatic digital voltage regulation system that is matched and prototype tested by the engine manufacturer with the governing system provided. It shall be immune from disoperation due to load-induced voltage waveform distortion and provide a pulse width modulated output to the alternator exciter. The voltage regulation system shall be equipped with three- phase rms sensing and shall control buildup of ac generator voltage to provide a linear rise and limit overshoot.
- B. The system shall include a torque-matching characteristic, which shall reduce output voltage in proportion to frequency below an adjustable frequency threshold. Torque matching characteristic shall be adjustable for roll-off frequency and rate and be capable of being curve-matched to the engine torque curve with adjustments in the field. The voltage regulator shall include adjustments for gain, damping, and frequency roll-off. Adjustments shall be broad range, and made via digital raise-lower switches, with an alphanumeric led readout to indicate setting level.
- C. Controls shall be provided to monitor the output current of the generator set and initiate an alarm (over current warning) when load current exceeds 110 percent of the rated current of the generator set on any phase for more than 60 seconds. The controls shall shut down and lock out the generator set when output current level approaches the thermal damage point of the alternator (over current shutdown). The protective functions provided shall comply to the requirements of NFPA 70, article 445.
- D. Controls shall be provided to individually monitor all three phases of the output current for short circuit conditions. The control/protection system shall monitor the current level and voltage. The controls shall shut down and lock out the generator set when output current level approaches the thermal damage point of the alternator (short circuit shutdown). The protective functions provided shall be in compliance to the requirements of NFPA 70, article 445.
- E. Controls shall be provided to monitor the kw load on the generator set and initiate an alarm condition (overload) when total load on the generator set exceeds the generator set rating for in excess of 5 seconds. Controls shall include a load-shed control, to operate a set of dry contacts (for use in shedding customer load devices) when the generator set is overloaded.
- F. An ac over/under voltage monitoring system that responds only to true rms voltage conditions shall be provided. The system shall initiate shutdown of the generator set when alternator output voltage exceeds 110 percent of the operator-set voltage level for more than 10 seconds, or with no intentional delay when voltage exceeds 130

percent. Under voltage shutdown shall occur when the output voltage of the alternator is less than 85 percent for more than 10 seconds.

OTHER CONTROL FUNCTIONS

- A. A battery monitoring system shall be provided which initiates alarms when the dc control and starting voltage is less than 25 volts dc or more than 32 volts dc. During engine cranking (starter engaged), the low voltage limit shall be disabled, and dc voltage shall be monitored as load is applied to the battery, to detect impending battery failure or deteriorated battery condition.

CONTROL INTERFACES FOR REMOTE MONITORING

- A. The control system shall provide 4 programmable output relays. These relay outputs shall be configurable for any alarm, shutdown, or status condition monitored by the control. The relays shall be configured to indicate: (1) generator set operating at rated voltage and frequency, (2) common warning, (3) common shutdown, (4) load shed command.
- B. A fused 10 amp switched 24 volt dc power supply circuit shall be provided for customer use. Dc power shall be available from this circuit whenever the generator set is running. (3) A fused 10-amp 24-volt dc power supply circuit shall be provided for customer use. Dc power shall be available from this circuit at all times from the engine starting/control batteries.

OTHER EQUIPMENT TO BE PROVIDED WITH THE GENERATOR SET

- A. The generator set shall be provided with a connection box for free conductors to three individually mounted circuit breakers outside of generator enclosure, no generator mounted circuit breaker is required.
- B. Outdoor weather-protective sound attenuated enclosure:
 - i. The generator set shall be provided with an outdoor sound attenuated enclosure, with the entire package listed under ul 2200. Sound rating not to exceed 75.8 dba at 7 meters. The package shall comply with the requirements of the national electrical code for all wiring materials and component spacing. The total assembly of generator set, including the enclosure shall be designed to be lifted into place using spreader bars. Housing shall provide ample airflow for generator set operation at rated load in an exterior ambient temperature of 100 degrees f. The housing shall have hinged access doors as required to maintain easy access for all operating and service functions. All doors shall be lockable and include retainers to hold the door open during service. Enclosure roof shall be cambered to prevent rainwater accumulation. To limit access of rodent's openings shall be screened into the enclosure. All electrical power and control interconnections shall be made within the perimeter of the enclosure.

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- i. All sheet metal shall be primed for corrosion protection and finished painted with the manufacturer's standard color using a two-step electro coating paint process, or equal meeting the performance requirements specified below. All surfaces of all metal parts shall be primed and painted. The painting process shall result in a coating that meets the following requirements:
 - a. Primer thickness, 0.5 to 2.0 mils
 - b. Topcoat thickness, 0.8 to 1.2 mils
 - c. Glossy per astm 0523-89i 80 percent plus or minus 5 percent
 - d. Gloss retention after one year shall exceed 50 percent
 - e. Crosshatch adhesion, per astm 03359-93, 4b-5b
 - f. Impact resistance, per astm 02794-93, 120-160 inch- pounds
 - g. Salt spray, per astm b117-90, 1000 plus hours
 - h. Humidity, per astm 02247-92, 1000 plus hours
 - i. Water soak, per astm 02247-92, 1000 plus hours
- ii. Painting hoses, clamps, wiring harnesses, and other non-metallic service parts will not be acceptable. The fasteners used shall be corrosion resistant and designed to minimize marring of the painted surface when removed for normal installation or service work.
- iv. Enclosure shall be constructed of minimum 12-gauge steel for framework and 14-gauge steel for panels. All hardware and hinges shall be stainless steel.
- v. A factory-mounted exhaust silencer shall be installed inside the enclosure. The exhaust shall exit the enclosure through a rain collar and terminate with a rain cap. Exhaust connection to the generator set shall be through seamless flexible connections.
- vi. The enclosure shall include the following maintenance provisions:
 - a. Flexible coolant and lubricating oil drain lines, that extend to the exterior of the enclosure, with internal drain valves
 - b. External radiator fill provision

Sequence of operation

- A. Generator set shall start on receipt of a start signal from remote equipment. The start signal shall be via hardwired connection to the generator set control.
- B. The generator set shall complete a time delay start period as programmed into the control.
- C. The generator set control shall initiate the starting sequence for the generator set. The starting sequence shall include the following functions:
 - i. The control system shall verify that the engine is rotating when the starter is signaled to operate. If the engine does not rotate after two attempts, the control system shall shut down and lock out the generator set and indicate "fail to crank" shutdown.

- i. The engine shall fire and accelerate as quickly as practical to start disconnecting speed. If the engine does not start, it shall complete a cycle cranking process as described elsewhere in this specification. If the engine has not started by the completion of the cycle cranking sequence, it shall be shut down and locked out, and the control system shall indicate, "Fail to start."
- iii. The engine shall accelerate to rated speed and the alternator to rated voltage. Excitation shall be disabled until the engine has exceeded programmed idle speed and regulated to prevent over voltage conditions and oscillation as the engine accelerates and the alternator builds to rated voltage.
- iv. On reaching rated speed and voltage, the generator set shall operate as dictated by the control system in isochronous state.
- v. When all start signals have been removed from the generator set, it shall complete a time delay stop sequence. The duration of the time delay stop period shall be adjustable by the operator.
- vi. On completion of the time delay stop period, the generator set control shall switch off the excitation system and shall shut down.
- vii. Any start signal received after the time stop sequence has begun shall immediately terminate the stopping sequence and return the generator set to isochronous operation.

PART 3 – EXECUTION

FACTORY TESTING

- A. The generator set manufacturer shall perform a complete operational test on the generator set prior to shipping from the factory. A certified test report shall be provided and reviewed as described in the project documents. Equipment supplied shall be fully tested at the factory for function and performance.
- B. Factory testing may be witnessed by the owner and/or the owner's representative. Costs for travel expenses will be the responsibility of the owner and/or representative or as described in the project documents. The manufacturer shall provide two weeks' notice prior to factory testing.
- C. The generator set factory tests on the equipment shall be performed at 100 percent rated load and rated power factor for four hours. Generator sets that have not been factory tested at rated power factor will not be acceptable. Tests shall include: running at full load, maximum power, voltage regulation, transient and steady-state governing, single step load pickup, and function of safety shutdowns.

End of Section 26 23 1.x



SECTION 26 55 22 LED LIGHTING

This document is provided as a reference for the design professionals working for American University. This document should not be used directly as written for project specifications. This document does not define products for maintenance replacement purposes, but rather should be used for renovation and new construction projects.

PART 1 – GENERAL

1.0 Summary

- A. This Section includes lighting design criteria, interior, exterior and emergency luminaires, as well as related installation guidelines.

2.0 Regulatory Agencies

- A. Lighting design should conform to the applicable requirements of the following agencies' most current edition of regulations and standards, unless otherwise stated:
 - 1. American National Standards Institute (ANSI)
 - 2. American Society for Testing Materials (ASTM)
 - 3. Environmental Protection Agency (EPA)
 - 4. Federal Communications Commission (FCC)
 - 5. Illuminating Engineering Society of North America (IESNA)
 - 6. National Electrical Manufacturers Association (NEMA)
 - 7. National Fire Protection Association (NFPA)
 - 8. Underwriter's Laboratories (UL)
 - 9. U.S. Green Building Council (USGBC)
 - 10. American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE)
 - 11. International Building Code (IBC)
 - 12. International Energy Conservation Code (IECC)

3.0 Record Drawings

- A. Lighting fixture record drawings shall be provided to the University in the form of standard catalog cuts and/or factory assembly drawings, and shall indicate the following:
 - 1. Luminaire type correlated to lighting plans



2. Luminaire and LED wattage and voltage
3. Complete photometric data
4. Manufacturer's name and catalog number including all fixture options
5. LED and driver types and manufacturer's name
6. LED/driver and fixture
7. Warranty information for fixtures/LEDs and drivers
8. LED equivalent or correlated color temperature (CCT), color rendering index (CRI), and beam spread when applicable
9. LED and Ballast Rated Life

B. Lighting control record drawings shall include the following:

1. Single line diagram showing all control components and associated wiring
2. Load schedule indicating circuit and zone number, light fixture types, LED source, and load per circuit or zone
3. Catalog cut sheets of control system components
4. Lighting control narrative describing control intent for programmable lighting system

C. Full size manufacturer's drawings should be provided for custom designed light fixtures.

4.0 Submittals

- A. Product Data: Arrange in order of luminaire designation. The submittals shall include data on features, ratings, listings, certifications, accessories, finishes, dimensions, emergency components, photometric data, and luminaire efficiency data.
- B. Installation, Operation, and Maintenance Manuals.

5.0 Substitutions

- A. Substitutions for light fixtures not specified in the Contract Documents shall be coordinated with the University's project manager and Facilities Management stakeholders.
- B. All fixture substitutions must be requested via a product substitution request in accordance with the Universities Design and Construction Standards and Division 1 requirements of the contract. If substitutions



are requested, the University is under no obligation to accept them.

PART 2 DESIGN CRITERIA

1.0 Illuminance Levels

Academic Building Areas	Illuminance Level (Foot-candles)
Computer Lab	30 fc
Conference Rooms	30 – 40 fc ³
Environmental Rooms- Workspace	50 - 60 fc ⁴
Environmental Rooms - Storage	15 fc
File/Mail	30 - 50 fc
Laboratories	50 - 60 fc ⁴
Libraries - General/Stacks	30 fc
Libraries - Reading Rooms	50 fc
Mechanical/Electrical rooms	20 fc
Offices	35 - 50 fc ⁴
Restrooms	15 fc
Storage areas	15 fc
Theaters ⁵	30 fc
Museums ⁶	20 fc

Residential Building Areas	Illuminance Level (Foot-candles)
Hallways	10 fc
Dining Areas	20 fc
Dormitory Rooms - General	10 fc
Dormitory Rooms - Desk	30-50 fc ⁵
Kitchens	50 fc



Laundry Rooms	30 fc
Lounges	30 c

Athletic Facilities	Minimum Horizontal Illuminance Level (Foot- candles)	Maximum Ratio (Minimum)	Uniformity (Maximum:
Baseball			
Infield	100	2.5:1	
Outfield	70	2.5:1	
Basketball (Indoor)	125 fc	1.7:1	
Football ⁷	100 fc	1.7:1	
Locker rooms	20 fc	N/A	
Soccer	150 fc	2.5:1	
Tennis	100 fc	2.5:1	
Track & Field	50 fc	2.5:1	
Training Facilities	50 fc	N/A	

- Higher values may be required if the space is used for videoconferencing.
- On work plane, including task lighting.
- On aisle, entrance and exit corridors as well as general work levels on stage. Theatrical lighting will be evaluated separately.
- On aisles, entrance and exit corridors. Exhibit lighting should be evaluated and located based on the needs and type of installation and be designed to meet IESNA recommendations based on the specific use and function of the exhibit.
- Includes task lighting.
- Reading taken at 36" above ground unless otherwise noted.
- Readings taken at grade.



If sports and athletic facilities are required to be used for televised events, the lighting designed in these facilities must meet IESNA and NCAA guidelines based on the type of facility and the broadcast category. Consideration must be given to both horizontal and vertical illumination for all areas intended to be included in the televised event.

Special and High Risk Use Areas such as wood shops, machine shops, workshops should be designed to allow for both general lighting levels and elevated lighting levels where tasks are performed. Lighting positions should be coordinated with the location of equipment and levels should meet IESNA standards for the specific tasks performed in each area.

3.0 Energy Efficiency & Conservation

- A. Lighting Power Density – All interior spaces should comply with the Lighting Power Density (LPD) defined by the most current edition of ASHRAE 90.1. LPD is expressed in terms of watts/square foot. Standards can be evaluated based on the “building method” or the “space method.”
- B. Building designs and fenestration shall be configured to provide the maximum advantage to daylight harvesting control schemes. Daylight harvesting control schemes shall be employed in all instances where the fenestration area of the room is equal to or exceeds 250 sq. ft.

4.0 Sustainable Design & Energy Conservation

- A. The USGBC Leadership in Energy and Environmental Design (LEED) Building Rating System should be used as a guideline for project lighting design. The Rating System (New Construction, Commercial Interiors, Core & Shell, etc.) most appropriate to the project type should be followed.
 - 1. If the New Construction (NC) rating system is deemed most appropriate, reference in particular the following credit sections; however additional sections may apply.
 - a. Sustainable Sites Credit 8 - Light Pollution
 - b. Energy & Atmosphere Credit 1 - Optimize Energy Performance
 - c. Indoor Air Quality Credit 6.1 - Controllability of Systems – Lighting
 - d. Indoor Air Quality Credit 8.1,2 - Daylighting & Views



- B. Projects shall meet energy and control requirements outlined in the most current version of ASHRAE 90.1 or referenced in the LEED guidelines as described above.
- C. The application of natural light is encouraged to minimize electric lighting requirements.
 - 1. Appropriate glare control must be provided on all windows and skylights. Automatic daylight harvesting (reducing electric lighting load when available daylight is sufficient for lighting requirements) is encouraged.
 - 2. Daylight harvesting utilizing continuous (i.e. not stepped) dimming should always be used in regularly occupied spaces, such as offices and classrooms, to prevent disruption to occupants. Daylight harvesting utilizing on/off switching is acceptable in transient spaces, such as lobbies, atriums, etc.
- D. A lower general light level is recommended in the office or other spaces where under cabinet or desk mounted adjustable task lighting is installed. Such that the net illumination level (as per above tables) is achieved as a result of combined room and task light sources.
- E. High reflectance finishes are recommended for all ceiling and wall surfaces to minimize required energy usage.
- F. Lighting systems should be designed to achieve the above recommended illuminance levels while minimizing energy consumption.
- G. Locate interior and exterior luminaires to minimize light trespass and glare to adjoining properties.
- H. Lighting levels in unoccupied public spaces such as lobbies with exterior views or dorm room corridors must at a minimum meet emergency access and egress levels. Consideration should be given to include the illumination of selected walls and vertical surfaces to provide the appearance of occupancy while maintaining the reduced energy levels.

5.0 Controls

- A. American University requires that interior spaces meet the control requirements defined by the currently recognized version of ASHRAE 90.1.



- B. Ceiling mounted occupancy sensors are preferred and should be used as a default approach to lighting control. Ceiling mounted sensor(s) should be placed in a space such that detection area(s) cover the entire space. When a corner or wall mounted sensor(s) is used it should be located on the “door wall” in the corner farthest from the door. Wall switch sensors will be considered for small spaces with the approval of the Facilities Management department.
- C. When available, occupancy sensors should be specified with isolated relays for future use by non-lighting systems (i.e. local HVAC VAV).
- D. Occupancy sensors shall be specified as the control method in all private offices, restrooms, classrooms, conference rooms, storage rooms and other enclosed areas of intermittent use.
 - 1. Override switches or dimmers should be incorporated in offices, conference rooms, and classrooms.
 - 2. Dual Technology (infrared and ultrasonic/microphonic) sensors should be used in private offices, conference rooms, and classrooms.
 - 3. Ultrasonic sensors are acceptable in restrooms without floor to ceiling partitions.
 - 4. Follow manufacturer's recommendations for coverage specification and sensor placement.
 - 5. Wireless sensors are allowed when battery life meets or exceeds a 10-year rated life and provide a low battery indicator.
 - 6. No lighting controls should be used in mechanical spaces with electrical distribution equipment, motors, pumps, shop equipment or other devices that without appropriate light levels would create a safety hazard.
- E. Where rooms are used for a variety of functions, provide multi-level switching, fixture zoning, or dimming to accommodate light level flexibility for occupants
- F. Where rooms are used for a variety of functions, provide multi-level switching, fixture zoning, or dimming to accommodate light level flexibility for occupants.



- G. Digital time switches with adjustable time setting should be provided for utility spaces containing large equipment.
- H. Consider the design of load shedding for lighting controls in larger new construction to provide feedback to central monitoring system at OCC.
- I. Lighting control systems should be tested and calibrated by the Contractor and should be sample tested by the Commissioning Agent for all projects.
- J. Interior lighting controlled by relay panels for code required automatic shut-off shall have local override switches.
- K. Programming of preset lighting control systems shall be coordinated with the University's project manager and building occupants. A record of the settings shall be provided to building occupants.
- L. Acceptable manufacturers shall be by the following manufactures or equal approved by the A/E of record and Facilities Management:
 - 1. Sensor Switch/Light
 - 2. Hubbell
 - 3. Lutron
 - 4. Wattstopper
 - 5. Cooper Controls
 - 6. Leviton

PART 3 – PRODUCTS

1.0 Drivers

- A. LED drivers shall be electronic type, labeled as compliant with radio frequency interference (RFI) requirements of FCC Title 47 Part 15, and comply with NEMA SSL 1 "Electronic Drivers for LED Devices, Arrays, or Systems". LED drivers shall have a sound rating of "A", have a minimum efficiency of 85%, and be rated for a THD of less than 20 percent at all input voltages.
- B. Dimmable LED drivers shall be 0-10V type. Dimmable LED drivers shall be capable of dimming without LED strobing or flicker across their full dimming range.



2.0 Luminaires

- A. Luminaires should be constructed and installed to allow easy access for luminaire maintenance. Lenses, reflectors, and connectors should be captive to fixture where practical.
- B. Lighting fixtures shall be of specification grade and listed or labeled by Underwriters Laboratories (UL) or an approved Nationally Recognized Testing Laboratory (NRTL).
- C. LED fixtures shall comply with the following: UL Standard 8750 "Light Emitting Diode Equipment for Use in Lighting Products", IES Standard LM-79 "Electrical and Photometric Measurements of Solid-State Lighting Products", IES Standard LM-80 "Measuring Lumen Maintenance of LED Light Sources", and IES Standard TM-21 "Projecting Long Term Lumen Maintenance of LED Light Sources".
- D. ANSI C78.377 "Specifications for the Chromaticity of Solid State Lighting Products" with LEDs binned within a maximum three-step Mac Adam Ellipse to ensure color consistency amongst luminaires of the same type.
- E. Provide lighting fixtures in accordance with the Fixture Schedule.
- F. Provide only LED fixtures with a Design Lights Consortium (DLC) listing, a U.S. Department of Energy (DOE) "LED Lighting Facts" label or a U.S. Environmental Protection Agency (EPA) ENERGY STAR label, which have demonstrated third-party testing verification.
- G. Recessed lighting fixtures shall be thermally protected.
- H. LED fixtures shall be modular and allow for separate replacement of LED lamps and drivers. User serviceable LED lamps and drivers shall be replaceable from the room side.
- I. Dimmable LED fixtures shall have either a 0-10 volt, 3-wire dimming driver, or a two-step (50%-100%) line voltage, two switch
- J. Interior Lighting
 - 1. Fixture types previously typically specified with incandescent or compact fluorescent lamp sources (i.e. recessed downlights) should use dimmable LED technology. American University prefers fixtures manufactured with replaceable LED "lamps" when possible, to avoid potential fixture mismatching upon failure. The design



professional must ensure that the specified dimming control is proven to work with the specific LED utilized for a given switch circuit and for typical replacement LED's and drivers likely to be used.

2. The University will consider acceptance of fixtures manufactured for incandescent lamps paired with LED replacement lamps meeting University Insurer's Certification standards (e.g. UL, FM, etc.). In these instances, the design professional must insure that the specified dimming control is proven to work with the specific LED lamp utilized and for the quantity designed for a given switch circuit.
3. Acceptable dimming protocols include 0-10V and Lutron standards. DALI, DMX or other dimming protocols must be specifically requested or approved by AU's Facility Management.
4. Mounting of luminaires above stairs and in locations that are higher than single floor ceiling heights shall be identified and actively coordinate with the University's Facility Management to confirm access to the fixtures is possible with available maintenance equipment.
5. Luminaires must be hard-wired. Flexible cord (SJO) connectors are not acceptable. MC cable is permitted.
6. Where luminaires from manufacturer's standard product lines do not meet the requirements of the project or application, custom designed fixtures are acceptable with approval by the University provided they meet the following criteria:
 - a. The fixture shall utilize commonly available LED, driver & lens types, preferably those used elsewhere on the project.
 - b. The entire fixture assembly must be listed by U.L. or other Nationally Recognized Testing Laboratory standards.
 - c. The lamp and ballast must be easily accessible for maintenance without major disassembly of the fixture.
7. Where required, luminaires should have low iridescent reflectors, baffles, and louvers.
8. Adjustable luminaires shall be capable of being locked into



position with a legible aiming angle for consistency between fixtures. These luminaires should have the ability to maintain focus position during lamp changes.

9. Luminaires shall bear U.L. label or other Nationally Recognized Testing Laboratory (NRTL) tested to U.L. standards.
10. Where luminaires utilize flat lenses, 100% UV stabilized virgin acrylic with minimum 0.125" thickness shall be specified. When lensed fixtures are specified in areas where the fixtures are subject to damage, polycarbonate lenses shall be specified in lieu of acrylic.
11. Luminaires with painted components should be painted after fabrication.
12. Fixtures using linear fluorescent lamps and electronic ballasts should use lamps and ballasts specified in the lamps and ballasts section of this document.
13. LED technology luminaires should have the following performance specifications:
 - a. Consider LED sources based on durability, energy efficiency, and reduced maintenance. The use should be approved by Planning and Project Management and Facilities Management prior to specification.
 - b. LED fixtures are to be provided by manufacturers with a minimum (8) years' experience and provide minimum (5) years warranty on all electrical parts.
 - c. LED components and fixtures shall comply with ANSI chromaticity standards, LM79 and IES LM-80 lumen maintenance testing standards.
 - d. Dimmable LEDs will utilize Constant Current Reduction or Pulse Width Modulation controls. The design professional is responsible for ensuring performance compatibility between specific LED fixtures and controls.
 - e. LED lighting systems with unmatched drivers and power supplies will not be considered.
 - f. Lumen packages sufficient to meet space design



requirements including: maximum watts/square foot allowed by current energy code uniformity ratios no greater than 5:1 (excluding non-critical lighting locations) and minimum IESNA light levels for the applicable space type. The assumed Driver mA rating should be indicated when reporting initial delivered lumens of a specified fixture.

- h. Lumen/Watt performance greater than 80, assuming Lumens are measured as delivered lumens @ 35-degree Celsius multiplied by a 90% Light Loss Depreciation Factor and Watts are the total system watts of the fixture. Lumen/Watt performance meeting or exceeding 100 is the University's goal.
- i. Rated life of 50,000 when lumens depreciated to 90% of initial rating using IESNA TM-21 testing methodology and data extrapolation. This is commonly referred to L90 rated life.
- j. DLC certification recommended and preferred.
- k. Color Rendering Index equal or greater than 80.
- l. Correlated Color Temperature of 3,500. Color changing LED luminaires shall provide full spectrum color changing capability through the use of red, blue, green and white (amber) LED's.
- m. Design professionals are required to provide LED fixtures that are compatible with existing or newly specified dimming controls.
- n. Facilities Management must approve any exceptions to the above specifications.

K. Exterior Lighting

- 1. Mission Statement: The University's primary mission for exterior lighting of the campus is to enhance safety. In the process, lighting should improve the appearance of the campus, be energy efficient, utilize long life sources to minimize maintenance and minimize light pollution. Lighting must be adaptable for future campus development and changing technologies and be responsive to input from campus users.



2. All measures should consider matching the University's existing campus exterior lighting LED standard. LED luminaires are rapidly evolving as the chosen source for illumination of all new pathway and drive lane lighting on AU's campus.
3. Exterior pathway light poles shall be either of the following existing fixtures. Any deviations must be pre-approved by the Planning and Project Management.
 - a. Washington Gas-Light Standard matching existing in style and specifications.
 - b. Shoebox type, of heavy-duty construction (noting that sheet metal base covers are not acceptable), matching existing in style and specifications.
4. Poles shall be spaced a maximum of thirty (30) feet on center.
5. Luminaires should be either located or specified to prevent possible damage from vandalism.
6. Exterior luminaires and poles shall have the ability to withstand wind speeds of 80 miles per hour.
7. Exterior wall packs, both new and replacement units, shall utilize induction or LED lamping. Fixtures shall have superior glare control with lighting directed downward. Fixtures with light distribution above 90 degrees shall not be acceptable.

D. LED Replacement Lamps

1. Approved Manufacturers: Philips, Osram Sylvania and GE
2. Consider LED sources based on durability, energy efficiency, and reduced maintenance. Planning and Project Management and Facilities Management should approve the use prior to specification.
3. LED lamps are to be provided by manufacturers with a minimum (8) years' experience and provide a minimum (2) years warranty on all electrical parts.
4. LED components and fixtures shall comply with ANSI chromaticity standards, LM79 and IES LM-80 lumen maintenance testing



standards.

5. Dimmable LEDs will utilize Constant Current Reduction or Pulse Width Modulation controls.
6. Design professionals are required to provide LED lamps that are compatible with existing or newly specified dimming controls.
7. LED lighting systems with unmatched drivers and power supplies will not be considered.
8. Lumen packages, beam spreads and main beam candlepower sufficient to meet space design requirements. The assumed Driver mA rating should be indicated when reporting initial delivered lumens of a specified fixture.
9. Lumen/Watt performance greater than 80, assuming Lumens are measured as delivered lumens @ 35-degree Celsius multiplied by a 90% Light Loss Depreciation Factor and Watts are the total system watts of the fixture.
10. Rated life of 25,000 when lumens depreciated to 90% of initial rating using IESNA TM-21 testing methodology and data extrapolation. This is commonly referred to L90 rated life.
11. DLC certification recommended and preferred
12. Color Rendering Index equal or greater than 80
13. Correlated Color Temperature of 3,500. Color changing LED luminaires shall provide full spectrum color changing capability through the use of red, blue, green and white (amber) LED's.
14. Design professionals are required to provide LED fixtures that are compatible with existing or newly specified dimming controls.
15. The Facilities Management department must approve any exceptions to the above specifications.
16. Retrofit LED lamps shall comply with NEMA SSL 4 "SSL Retrofit Lamps: Suggested Minimum Performance Requirements".



E. Emergency Lighting

1. A dedicated Emergency Lighting Inverter System or Emergency Generator shall provide all emergency lighting. The use of Emergency Battery Ballasts installed in lighting fixtures should not be considered.
2. Provide self-contained emergency lighting units in all generator, switchgear, ATS, and UPS rooms, regardless of whether or not generator power is available on the project.
3. All new exit signs shall utilize LED lamping.
4. Self-powered exit signs should be provided with sealed maintenance-free batteries (with at least a 10-year warranty inclusive of battery life) and self-diagnostics.
5. When generator power is unavailable, self-contained emergency battery units are acceptable for code required egress lighting. Coordinate with the Planning and Project Management and Facilities Management.
6. Radioactive self-luminous exit signs are not acceptable. Self-luminous exit signs that are toxin free may be considered on a case-by-case basis.
7. Emergency lighting levels shall meet National Fire Protection Association (NFPA) 101 and International Building Code (IBC) requirements.
8. Identified Egress Paths (i.e. corridors, stairwells & assembly areas) must meet both currently adopted code requirements for minimum illumination levels and sufficient directional signage when normal power is not available.

F. WARRANTY

1. For non-LED lighting fixtures and components, provide a complete warranty for parts and labor for a minimum of one year from the date of Substantial Completion.
2. For LED fixtures, lamps, drivers, and components, provide a complete warranty for parts and labor for a minimum of five years from the date of Substantial Completion.



PART 4 – EXECUTION

- A. All luminaires recessed or suspended from the ceiling shall be supported by the structure above the ceiling at a minimum of two locations for every four feet of fixture length.
- B. The Contractor shall provide a list of Luminaire (fixture, LED and driver) types used on the project with the associated installation locations noted.
- C. All adjustable interior and exterior light fixtures should be aimed by the Contractor to the satisfaction of the A/E and the University.
- D. The contractor will be responsible for the coordination for programming of programmable lighting control systems. This includes providing factory trained technicians for programming and commissioning of the systems as well as training of personnel responsible for the upkeep of the systems as well as arranging a time conducive to both client and design team to meet and provide direction to the programmer.

END OF SECTION 26 52 22

END OF DIVISION 26



DIVISION 27 COMMUNICATIONS

GENERAL

The Owner will contact the Office of Information Technology (OIT) before beginning work on the design of a renovation or new facility. OIT will coordinate data and voice communications for the project.

The Owner's project management representative will coordinate with a team of communication engineers, technicians and support personnel to meet the scope of the project.

American University has many different voice, data and video requirements that rely on a high quality, reliable and flexible wiring infrastructure to meet the ever-changing demands of its faculty and staff.

The diversified options vary from building to building and require a great deal of planning. This team will provide space requirements for the communication rooms, distribution design assistance/approval, and cost estimates. They will also assist with the coordination of all communication wiring and equipment.

AU OIT is responsible for termination and activation and the CM/GC is responsible for running any new communications wiring unless otherwise stated. These costs will be budgeted by AU into the project by the offices of the Planning and Project Management or Capital Program Management.

OIT will not take occupancy of any space until it is completed, commissioned, punch list complete and cleaned per OIT standards for installation of communications equipment.

The consultant shall identify equipment requiring emergency power during development of the Owners Program Requirements and incorporate emergency power for required communications to include necessary building support systems.

BUILDING COMMUNICATIONS SERVICE ENTRANCE

All communications cabling on the AU campus is installed in underground ducts encased in concrete. During schematic design, OIT will specify the route and building entrance location. At that time, OIT will assist in developing the best size and number of conduits to anticipate ultimate requirements for service and emergency needs.

Construction drawings shall provide for an equal number of conduits extending from a manhole 5'-0" outside the building and will terminate in the building's main entry communications room (BCR) as described later in this booklet. In this room and as close to the entrance conduit as possible, a minimum of one (1) #4 copper ground cable is required.



Where the entrance conduits penetrate the foundation, footings or outside walls, rigid metallic conduit shall be used. Plaster fiber ducts or aluminum conduit will not be accepted. At the point of exit, a minimum of 2'-0" ground cover must be maintained.

If existing conditions should alter this setup, an OIT Communications Analyst should be notified and alternatives worked out.

COMMUNICATION ROOMS

A single communications room or Main Distribution Frame (MDF) may serve a floor area as large as 20,000 square feet provided it serves only the telephone and data needs on the same floor and that additional satellite rooms or Intermediate Distribution Frames (IDF) are provided on other floors. Connecting conduit is required to ensure that the greatest distance from any communications outlet to the nearest communication room does not exceed 300 linear feet

Minimum space requirements for communication rooms are listed below along with general notes to be considered during planning and design. Please note each project is different and larger space requirements may be needed for communication rooms because of the user's expanded voice/data requirements or size of the facility.

Once again, early consultation with the American OIT communications analyst is a must to ensure size of communication rooms are adequate to meet user and facility needs.

MAIN DISTRIBUTION FRAME (MDF)

The MDF shall be:

- A. A minimum of 150 sq. ft. (minimum width 6') and will provide a 2 ft clearance on each side for telephone equipment and 19" racks on which data electronics and power equipment are normally mounted. This room size will provide service to approximately 20,000 square feet of building.
- B. A single, solid door 3'-0" in width with a 180-degree hinge shall be provided and mounted to swing outside the room if possible, by code.
- C. Located off a corridor or an area not associated with business offices and other high activity areas.
- D. A well-sealed tile floor is required. (No carpeting)
- E. Open, non-finished ceiling spaces are preferred. HVAC ducts, plumbing lines (water, soil, or steam), sprinkler heads and piping installed through this space will not be acceptable. No utilities except those serving the room may occur in or above this room.
- F. All internal wall surfaces shall be lined with unpainted pressure treated fire retardant 3/4" plywood 8' high.
- G. Fluorescent light fixture(s) will be required. See Division 26 electrical.
- H. If emergency power is available in the building, these circuits shall be connected to this power source and labeled. Contractor shall indicate on drawings whether



emergency power is a generator or a UPS.

- I. Conduits entering these spaces shall penetrate the closet walls at a height above the plywood panels and extend only far enough to install bushings. Overhead ladder racks shall be designed, provided and installed by American OIT to support wiring.
- J. Fire stops around cables will be sealed or plugged with fiberglass one inch (1") thick topping of water plug cement or equivalent. Unused conduits will be plugged and capped for fire proofing as specified above or as required for fire code rating. Additional fire stop or other requirements by the University insurance provider shall be followed.
- K. A minimum of 15,000 BTU of cooling is required and the room shall be positive with respect to the corridor or area adjoining these rooms. Auxiliary air conditioning units may be required in closets with a large number of data/phone electronics devices.
- L. Tie-in to the Building Automation System typically is required, see Division 25 for control and/or monitoring and alarm requirements.
- M. Supply a ground connection from a cold water pipe or building ground system utilizing a minimum #6 bare copper conductor. Leave 6' coil in each room.

Caution: Room square footage is dependent on equipment serving the building. Contact American University OIT for exact footage required.

INTRA-BUILDING DISTRIBUTION SYSTEM

In all buildings at American University, communication horizontal and vertical distribution systems are an absolute necessity in meeting and in keeping pace with the occupants' voice, data, and video communications needs.

HORIZONTAL

New buildings should be designed to include a means for an open cable tray communication distribution system. Due to the different styles and types of cable tray systems available minimum standards require the tray to be a minimum of 12" wide and 4" deep. The tray shall be open on top and suspended from the ceiling by supporting rods in the middle of the tray or as recommended by the manufacturer. No rod threads should be exposed in the cable tray due to easy damage of cable when being pulled.

To deter the use of plenum cable, open wire-ways can only be used in air return spaces for very special cases.

A minimum of one inch (1") conduit shall be used from the cable tray to the user's communication outlet to house communications cabling.



Renovation projects are very different in nature and require very early consultation with an AU Tele/Video Communications analyst to insure all existing and future requirements are met for communication distribution systems in consultation with the Project Manager.

VERTICAL

New multi-level buildings should be designed with communication rooms (IDF's) placed one above the other in a vertical fashion to facilitate vertical distribution systems. The size and quantity of conduit between each of the communication rooms will depend on the size and functionality of the building. Early consultation with an e-operations analyst is required to ensure all requirements are met.

END OF DIVISION 27



DIVISION 28 ELECTRONIC SAFETY AND SECURITY

DESIGN CONSIDERATIONS

The Consultant shall provide a written description of how the entire system is designed to operate. This Basis of Design (BOD) narrative also shall describe how project objectives are being met. It shall be provided in a format that can be easily understood by a layperson, the end user. The narrative identifies items that specifically meet the Owners Project Requirements (OPR) and the most recent University Safety and Security Services (USSS), Facilities Management (FM) department System Master Plan(s) and articulate a rationale for any variance.

For renovations, the systems selected shall be compatible with the existing building's electronic safety and security systems. The integrity of the basic existing building system shall not be compromised. Work shall be designed and sequenced to minimize impact and interruptions in occupied buildings.

For site work, the Consultant shall indicate all existing underground work such as piping, valves, manholes, electric wiring and telephone, whether new connections are being made or not. Profiles of all piping need to be shown to facilitate coordination with the crossing of other utilities.

New buried cabling shall have location detection added per Division 26 requirements.

Provide extended service and maintenance options with every new project. Local vendors shall list and verify compliance response times for planned routine maintenance, urgent schedule repairs and emergency service as required in the OPR.

The Consultant shall incorporate any requirements from the University insurance carrier or USSS into the design and specifications.

SECURITY SYSTEMS

The American University (AU) USSS has established security standards and emergency notification standards for all University buildings. These standards encompass the technology and physical security features required to protect the AU community and buildings.

While the standards reflect best business practice and represent industry standards, they are applied based on security assessments of plans for newly constructed buildings and major renovations and take into account-planned uses of each facility and its occupants. These assessments and the application of these standards are intended to foster a uniform level of security associated with university structures, both within and exterior to the buildings.

The standards or variations of the standards, for each project are applied based on



recommendations of the USSS.

INTERIOR ACCESS CONTROL, MONITORING, AND CCTV

AU's electronic security program is comprised of three primary sub-systems; access control, intrusion detection and close circuit television systems. All systems are managed by USSS. All security design documentation and security equipment shall require prior approval by the AUPD physical security manager and be furnished by the security contractor unless otherwise noted.

All security and emergency notification system designs for new buildings and major renovations are prepared in partnership with the Planning and Project Management department. Application of these standards to existing buildings/locations on campus will be at the direction of the USSS based on a risk and threat analysis.

The AUPD unit also maintains lists of approved security hardware and will provide the information upon request. This hardware is standardized across campus and the USSS Physical Security Manager must approve variations from the list.

DETAILS

Contractor shall provide typical installation drawings prior to the commencement of any work for approval by the physical security manager. The contractor shall also provide as-built drawings after the installation is complete.

CONTACTS

Questions concerning the University's security management system guidelines should be addressed to Physical Security Manager (202) 885 2527.

ACCESS CONTROL SYSTEMS – 28 13 00

USSS is responsible for all integration and daily management of the Software CCure 9000 Management System for academic, administrative and housing facilities. This includes termination, installation, maintenance and monitoring of all equipment associated with this system. This also includes providing all card reader equipment.

The Consultant or Project Manager should consult with the USSS Physical Security Manager during the design and construction phases of any project that includes card readers.



ACCESS CONTROL HARDWARE DEVICES – 28 15 00

EXTERIOR DOOR CONTROL AND MONITORING

Provide conduit path from door area to security panel closet or equivalent for card readers, door contacts and associated equipment. This applies to all exterior doors. All security design documentation and security equipment shall require prior approval by the USSS Physical Security Manager and be furnished by the security contractor unless otherwise noted.

DOOR SECURITY

The design should provide a 3/4" conduit from the door area to a designated location in a communications closet. The Contractor is to pull the wire specified or provided by the USSS from the security panel closet to door area. In the security panel closet, the contractor is to provide and install 3/4" fire-rated plywood on wall where the Access Control panel will be mounted.

If the security panel closet is separate from the telephone entry room, provide 2" conduit connecting them. Provide 1" conduit from the security panel closet to the fire alarm control panel.

In the security panel closet, provide one dedicated 120-volt duplex receptacle for required power. This power is to be on the emergency generator for the building if a generator is present. Refer all questions or concerns to the USSS Physical Security Manager.

The light fixture in the security panel closet is to be on the emergency generator if a generator is present. Refer all questions or concerns to the AU Master Electrician. All buildings requiring electronic security locking hardware must be Fail Secure in functionality unless otherwise noted. The physical security manager must approve all work prior to installation.

VIDEO SURVEILLANCE CLOSED CIRCUIT CAMERA SYSTEM – 28 20 00

USSS is responsible for the integration and daily management of the Genetec Security Desk/Omicast video management system. This includes termination, installation, maintenance and monitoring of all equipment associated with this system.

The Consultant or Project Manager should consult with the university's physical security manager during the design and construction phases of any project that includes a requirement for video monitoring equipment.



INTRUSION DETECTION – 28 31 00

The Project Manager should consult with the USSS Physical Security Manager during the design and construction phases of any project to determine the intrusion detection requirements for the project.

FIRE ALARM SYSTEMS – 28 46 21.1x

The Fire Alarm system is maintained by Facilities Management Energy & Engineering Department. It is a campus wide system monitored 24/7 by AUPD.

Refer to separate section 28 46 21.1x for university fire alarm system requirements. Address questions or concerns to the AU Master Electrician.

REFRIGERANT MONITORING – 28 44 00

See product requirements at the end of this division.

See also monitoring, graphic and alarm notification and integration requirements to the Building Automation Systems in Division 25.

MASS NOTIFICATION SYSTEMS – 28 47 00

The Emergency Notification Systems are comprised of two sub systems: A system that permits USSS to make public announcements of emergencies affecting the university, and a system that allows individuals to contact USSS to report an emergency.

Each mass notification must be tested and/or undergo integrated commissioning at the 100% device level.

EQUIPMENT NUMBERING SCHEME

- First Identifier** – Identifier for the building that the equipment is associated with. This will be consistent with the established computerized maintenance management (AiM) building identifier codes existing in the AiM system.
- Second Identifier** – Floor location of the equipment if the building is multi-level, having more than a basement and a first floor.
- Third Identifier** – Type of equipment that is being identified. Abbreviated equipment type code consistent with existing AiM established codes.
- Fourth identifier** – This will indicate the incremental number of the item according to the location. The incrementing should begin with the lowest physical level of the building.



Examples of Asset Codes for AiM:

If there are 3 VAV units on the first floor and 3 on the third floor and 2 Fan coil units on the first floor and 5 on the third floor in Anderson Hall the AiM asset numbering codes will be:

AH-01-VAV001 VAV BOX
AH-01-VAV002 VAV BOX
AH-01-VAV003 VAV BOX
AH-03-VAV004 VAV BOX

AH-03-VAV005 VAV BOX
AH-03-VAV006 VAV BOX

AH-01-FCU001 FAN COIL UNIT
AH-01-FCU002 FAN COIL UNIT
AH-03-FCU003 FAN COIL UNIT

AH-03-FCU004 FAN COIL UNIT
AH-03-FCU005 FAN COIL UNIT
AH-03-FCU006 FAN COIL UNIT
AH-03-FCU007 FAN COIL UNIT

Refer to the document Schematic Equipment and Building Codes for existing identifiers. Consult with the Facilities Management Planned Maintenance Manager prior to assigning equipment identifiers the contract documents. List AiM number on building documents including equipment schedule. Equipment shall be labeled consistently across all disciplines.

Resolution of equipment not associated with buildings.

There are some items identified as equipment that are not associated with any building. These are equipment items for the Grounds Maintenance Operation (mowers, tillers, clippers, etc.). Other items are unique to the housekeeping operation (vacuums). Equipment that is affixed to the facility or requires special connections shall be identified in the project documents by the corresponding AiM equipment asset identification.

DIVISION 28 ELECTRONIC SAFETY AND SECURITY PRODUCTS

Subject to compliance with project requirements, basis-of-design manufacturer(s) (and model number if applicable) shall be:

- Fire Alarm System
1. Siemens XLS



Card Access System

1. CCure

Refrigerant Monitor

1. Sherlock with infrared refrigerant sensors

Subject to compliance with project requirements, acceptable manufacture(s) include, but are not limited to the following:

All products in this Division require integration into existing systems. No exceptions. New product use only with Departmental approval.

END OF SECTION



SECTION 28 46 21.1x FIRE ALARM SYSTEMS

This document is provided as a reference for the design professionals working for American University (AU). This document should not be used directly as written project specifications. This document does not define products for maintenance replacement purposes, but rather should be used for renovation and new construction projects.

The American University Facilities Management Life Safety Manager/Master Electrician has established standards for fire alarm systems to protect the AU community and buildings. While the standards reflect best business practice and represent industry standards, they are applied based on assessments of plans for newly constructed buildings and major renovations and take into account planned uses of each facility and its occupants. These assessments and the application of these standards are intended to foster a uniform level of protection and notification associated with university structures, both within and exterior to the buildings. The standards, or variations of the standards, are applied based on recommendations to Facilities Management developed through the Life Safety Master Plan and in consultation with University Safety and Security (USSS) and the university insurance provider.

The USSS Physical Security Unit also maintain lists of approved security hardware and will provide the information upon request. This hardware is standardized across campus and the physical security manager must approve variations from the list.

All security and emergency notification system designs for new buildings and major renovations are prepared in partnership with the Planning and Project Management department. Application of these standards to existing buildings/locations on campus as of May 2016 will be at the joint direction of Facilities Management and University Safety and Security Services based on objectives in the current departmental Master Plans and a detailed risk and threat analysis. The Designer shall consult with Facilities Management and Safety/Security requirements for commissioning in accordance with NFPA 3 Standard Commissioning of Fire Protection and Life Safety Systems and NFPA 4 Standard for Integrated Fire Protection and Life Safety System Testing.

American University fire alarm systems campus-wide are Siemens only, hard wired. Refer to MANUFACTURERS later in this document.

PART 1 – GENERAL

RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. Provisions of Division 26 Electrical including labeling, wiring practices, fire stop, and general provisions, apply to this Section.



SUMMARY

- A. The system shall include all wiring, raceways, terminal cabinets, pull boxes, outlet and mounting boxes, initiating devices, alarm indicating devices, annunciators, printers, control equipment, and all other accessories and miscellaneous items required for a complete operating system even though each item is not specifically mentioned or described.
- B. Related Standards: The following standards contain requirements that relate to this Section: "Fire Protection" for water-flow, pressure, or tamper switches connected to fire alarm system.

DEFINITIONS

- A. Alarm-Initiating Device: A manual station, smoke detector, heat detector, flame detector, or sprinkler water-flow switch.
- B. Alarm Signal: Signifies a state of emergency requiring immediate action. Pertains to signals such as the operation of a manual station and the operation of a sprinkler system flow switch.
- C. Class A Wiring: Circuits arranged and electrically supervised so a single break or single ground fault condition will be indicated by a trouble signal at the fire alarm control panel (FACP) and the circuit will continue to be capable of operation for its intended service in the faulted condition no matter where the break or ground fault condition occurs.
- D. Class B Wiring: Circuits electrically supervised such that a single break or a single ground fault condition will be indicated by a trouble signal at the FACP no matter where the break or ground fault condition occurs.
- E. Hard-Wired System: Alarm, supervisory, and initiating devices directly connected, through individual dedicated conductors, to a central control panel without the use of multiplexing circuits or devices.
- F. Multiplex System: One using a signaling method characterized by simultaneous or sequential transmission, or both, and the reception of multiple signals in a communication channel, including means for positively identifying each signal.
- G. Supervisory Signal: Indicates abnormal status or need for action regarding fire suppression or other protective system.
- H. Trouble Signal: Indicates that a fault, such as an open circuit or ground, has occurred in the system.
- I. Zone: A building area, which has all initiating devices located within it programmed to initiate an alarm and to give a common visual location indication on the system annunciator.

SYSTEM DESCRIPTION

- A. General: This specification intends to describe an integrated fire detection and voice evacuation system to be intelligent device addressable, analog detecting, low-voltage and modular with multiplex communication techniques in full compliance with all applicable codes and standards. The features described in this



specification are a requirement for this project and shall be furnished by the successful contractor.

- B. Signal Transmission: Multiplex signal transmission dedicated to fire alarm service only.
- C. Audible Alarm Indication: By sounding of voice evacuation via speakers.
- D. System connections for alarm-initiation and alarm-indicating circuits: Class B wiring.
- E. Functional Description: The following are required system functions and operating features:
 - i. Priority of Signals: Accomplish automatic response functions by the first zone initiated. Alarm functions resulting from initiation by the first zone are not altered by subsequent alarms. The highest priority is an alarm signal. Supervisory and trouble signals have second- and third-level priority. Signals of a higher-level priority take precedence over signals of lower priority even though the lower-priority condition occurred first. Annunciate all alarm signals regardless of priority or order received.
 - ii. Non-interfering: Zone, power, wire, and supervise the system so a signal on one zone does not prevent the receipt of signals from any other zone. All zones are manually re-settable from the FACP after the initiating device or devices are restored to normal. Systems that require the use of batteries or battery backup for the programming function are not acceptable.
 - iii. The system shall monitor all alarm initiating and supervisory devices, initiate audible and visual alarm, supervisory and trouble signals, initiate automatic elevator recall, de-energize magnetic door holders, initiate shutdown of air handling units whether in automatic or hand operation, close respective fire/smoke dampers, operate smoke control systems, operate smoke relief hatches, provide alpha/numeric display of alarm, supervisory and trouble conditions at the fire alarm control panel, provide a hard copy record of system events, provide LED annunciation at all remote annunciators, and transmit required signals to a remote central station.
 - iv. Silencing at FACP: Switches provide capability for acknowledgment of alarm, supervisory, trouble, and other specified signals at the FACP; and capability to silence the local audible signal and light a light-emitting diode (LED). Subsequent zone alarms because the audible signal to sound again until silenced in turn by switch operation. Restoration to normal of alarm, supervisory, and trouble conditions extinguish the associated LED and cause the audible signal to sound again until the restoration is acknowledged by switch operation.
 - v. Loss of primary power at the FACP sounds trouble signal at the FACP and indicates at the FACP when the system is operating on an alternate power supply.
 - vi. Annunciation: Manual and automatic operation of alarm-and-supervisory-initiating devices is annunciated both on the FACP and on the annunciator, indicating the location and type device.



- vii. FACP Alphanumeric Display: Displays plain-language description of alarms, trouble signals, supervisory signals, monitoring actions, system and component status, and system commands.
 - viii. Remote Detector Sensitivity Adjustment: Manipulation of controls at the FACP causes the selection of specific addressable smoke detectors for adjustment, display of their status and sensitivity settings, and control of changes in those settings. The same controls can be used to program repetitive, scheduled, automated changes in sensitivity of specific detectors. The system printer records sensitivity adjustments and sensitivity adjustment schedule changes.
- F. Recording of Events: Record all alarm, supervisory, and trouble events by means of the NCC-WAN printer. Printouts are by zone, device, and function. When the FACP receives a signal, the alarm, supervisory, and trouble conditions are printed. The printout includes the type of signal (alarm, supervisory, or trouble) the zone identification, date, and the time of the occurrence. The printout differentiates alarm signals from all other printed indications. When the system is reset, this event is also printed, including the same information concerning device, location, date, and time. A command initiates the printout of a list of existing alarm, supervisory, and trouble conditions in the system.
- i. Permissible Signal Time Elapse: The maximum permissible elapsed time between the actuation of any fire alarm or fire-detection system alarm-initiating device and its indication at the FACP is ten seconds.
 - ii. Circuit Supervision: Indicate circuit faults by means of both a zone and a trouble signal at the FACP. Provide a distinctive indicating audible tone and (LED) indicating light. The maximum elapsed time between the occurrence of the trouble condition and its indication at the FACP is 200 seconds.

SYSTEM OPERATION:

- A. Activation of any system fire, security, supervisory, trouble, or status-initiating device shall cause the following actions and indications in the Fire Command Center at University Safety and Security Services in the NCC Network Command Center. The USSS command center is located on East Campus, lower level of the Don Meyers Technology and Innovation Building.
- B. Fire Alarm Condition:
 - i. Sound an audible alarm and display a custom screen/message defining the building in alarm and the specific alarm point initiating the alarm.
 - ii. Log to the system history archives all activity pertaining to the alarm condition.
 - iii. A simultaneous message shall be delivered via all alarm speakers including those installed in stairways and elevators informing occupants of the imminent shutdown of elevator circuits and the expected high traffic load in the stairwells.



- iv. An automatic announcement or tone evacuation signal shall be capable of interruption by the operation of the system microphone to give voice evacuation instructions overriding the pre-programmed sequences.
 - v. Status lights next to speaker selection switches on the control panel shall indicate speaker circuit selection.
 - vi. Audible signals shall be silenced from the fire alarm control panel by an alarm silence switch. Visual signals shall be programmed to flash until the system reset or alarm silencing, as required by the local District of Columbia Fire Marshal or designated authority having jurisdiction (AHJ).
 - vii. A signal dedicated to the sprinkler system water flow alarm shall not be silenced while the sprinkler system is flowing at a rate of flow equal to a single head.
 - viii. Activation of any smoke detector in a single elevator lobby or an elevator equipment room shall cause the recall of that bank of elevators to the 1st floor and the lockout of controls. In the event of recall initiation by a detector in the first floor lobby, the recall shall be to the alternate floor as determined by the AHJ. Furthermore, any single device activation in a Residence Hall will trigger this same "lobby" recall response.
 - ix. Where indicated in the drawings heat detectors in elevator shaft and machine rooms shall activate an elevator power shunt trip breaker. The heat detectors shall be rated at a temperature below the ratings of the sprinkler heads in respective locations to insure that the power shall be shut off before activation of sprinkler system.
 - x. Remote LCD annunciators shall display the alarm condition via unique messages as required by the system owner. LED type annunciator displays, conventional and graphic style shall indicate alarm zoning as specified.
 - xi. System operated duct detectors as per local requirements shall accomplish HVAC shut down.
 - xii. Door closure devices shall operate by floor or by local requirements.
 - xiii. Activation of Stairwell pressurization, Smoke purge, and damper control shall be as required and operated as per local requirements.
 - xiv. Print alarm conditions on NCC-WAN printer located at the USSS office at East Campus.
- C. Supervisory Condition:
- i. Display the origin of the supervisory condition.
 - ii. Activate supervisory audible and dedicated visual signal.
 - iii. Audible signals shall be silenced from the control panel by the supervisory acknowledge switch.
 - iv. Record within the system the initiating device and time of occurrence of the event.
 - v. Print supervisory condition to system printer.
 - vi. Remote LCD annunciators shall display the supervisory condition via unique messages as required by the system owner. LED type annunciator displays, conventional and graphic style shall indicate alarm zoning as specified.



D. Trouble Conditions

- i. Display the origin of the trouble condition.
- ii. Activate trouble audible and visual signals at the control panel and as indicated on the drawings.
- iii. Audible signal shall be silenced from the fire alarm control panel by a trouble acknowledge switch.
- iv. Trouble reports for primary system power failure to the master control shall be automatically delayed for a period equal to 25% of the system standby battery capacity to eliminate spurious reports because of power fluctuations.
- v. Record within system history, the occurrence of the event, the time of occurrence and the device initiating the event.
- vi. Print trouble condition to system printer.
- vii. Remote LCD annunciators shall display the trouble condition via unique messages as required by the system owner. LED type annunciator displays, conventional and graphic style shall indicate alarm zoning as specified.

SUBMITTALS

- A. No substitutions of equipment or materials shall be allowed.
- B. Submittals must be signed by NICET Level IV Senior Engineering Technologist employed by Siemens Industry, Inc., 6435 Virginia Manor Road, Beltsville, MD 20705.
- C. Provide six (6) sets of complete submittals which shall include drawings of all annunciator panel graphics, schematic wiring drawings of the control panel showing internal and external control panel wiring and all devices. Sequence of operation, annunciator wiring and faceplate drawings, specification sheets for all equipment, all devices, and battery calculations shall be provided. Drawings of the control panel and graphic annunciator panel(s) shall be done on 30" x 42" sheet size. Partial submittals will not be accepted.
- D. Submittals shall be provided in accordance with the project submittal schedule as outlined in the Division 1 General Requirements of the contract or the contract project manual.
- E. If re-submittals are required, they shall be provided within two (2) weeks after the date of notification. If re-submittals are not received by the Engineer in two (2) weeks, the supplier will be considered non-responsive and subsequent submittals from the supplier will not be reviewed. The Contractor shall then provide submittals from another equipment supplier within two (2) weeks as directed by the Owner at no change in contract price.
- F. The cost of reviewing any submittals after two (2) submittals have been disapproved shall be paid by the Contractor to the Engineer. The Contractor shall then deliver a purchase order to the Engineer before any submittals will be reviewed.

RECORD DOCUMENTS

- A. The As-Built drawings shall include one (1) complete set of 30" x 42" contract base sheet drawings with any and all changes included and noted. The approved contract panel drawings and graphic annunciator panel drawings shall also be



- provided in PDF format. The Conduit Plan shall show the device address for all intelligent/analog initiating devices. The electrician in charge of the system installation shall keep the As-built drawings up to date continuously. These drawings shall be reviewed on a weekly basis for accuracy and completeness.
- B. The Operation and Maintenance Manual shall include a complete set of equipment, component and device specification and data sheets as well as a reduced size paper copy (11" x 17") of the complete set of system drawings described in the specification section A copy of the NFPA 72 Test Report/Certificate, the printer record of all test activity including the sensitivity readings for all intelligent/analog smoke detectors, the required system and component warrantee papers, and the name and address of the installer shall be included. The manual shall be bound in a black three-ring loose-leaf binder with dividers and a table of contents. Four (4) duplicate sets are required or as otherwise required in the contract documents.
 - C. Six (6) sets of keys to all locks shall be provided at occupancy with each set of keys properly and legibly marked and tagged. Loose keys will not be accepted. Transmit to Facilities Management Material Supply Manager and Life Safety Manager jointly for acceptance at occupancy.
 - D. All documents and items described above shall be submitted for approval and turnover prior to the final testing and system certification with the exception of the NFPA 72 Test Report/Certificate that shall be delivered by hand to the Owner within two (2) days of the actual test and acceptance.

QUALITY ASSURANCE

- A. Qualifications of the Installer: an electrical contractor experienced in the installation of fire alarm systems shall install the system. A minimum of five years verifiable installation of fire alarm systems is required for both the firm and the site supervisor.
- B. The name of the electrician who will be responsible for the fire alarm system installation shall be submitted for the Owner's approval before any work is started on the system. The qualifications and experience of the proposed individual shall also be included. The Owner-approved fire alarm installation electrician shall remain on this project until the fire alarm system is accepted by the Owner.
- C. The services of a technician who has been trained and certified by the manufacturer of the equipment being supplied shall be provided to supervise the installation, adjustments, tests and final connections and certification of the system.
- D. The system control panel, annunciators, devices specified, and their installation and operation shall conform to the most stringent applicable requirements of the following publications and this specification unless otherwise noted:
 - i. NFPA 70 The National Electric Code
 - ii. NFPA 72 The National Fire Alarm Code
 - iii. NFPA 90A
 - iv. BOCA
- E. The control panel, annunciators, all initiating and indicating devices and all other devices connected to the system shall be UL Listed as provided and shall bear UL



and Construction Standards (archived) for applicable specification requirements.
The equipment shall be Siemens type MXLV.

END OF SECTION



DIVISION 31 EARTHWORK

GENERAL

American University views the campus site as an integral piece of the University mission and takes advantage of the unique urban setting to provide students, faculty, staff and the local community direct involvement in sustainability initiatives. The Arboretum Master Plan underscores the dedication to environmental and social responsibility while providing for needed infrastructure. The Project Manager and Designer will:

- Develop site designs that complement the existing campus landscape
- Minimize impact on existing trees and amenities through protection or relocation
- Consult with American University Landscape Architects
- Consult with American University Energy and Engineering
- Contain erosion control, including runoff reduction and sediment control
- Include site specific Facilities Management Master Plan requirements

DESIGN CONSIDERATIONS

Dewatering discharge shall be at approved locations only.

Store and stockpile materials at approved locations only. Do not reuse removed materials unless specifically approved by the University.

Warning tape, color coded for type of service, is required for all buried work. Drawings submitted for record must reference elevations as required by the design team.

EXECUTION

The contractor will protect the existing site and restore any damage to the satisfaction of the University. This includes, but is not limited to sidewalks and pavers, existing vegetation and irrigation, roadways, utility poles, drains and covers, and street signs.

Product selections by the Designer will be included in the Basis of Design for Facilities Management review and concurrence.

END OF DIVISION 31



DIVISION 32 EXTERIOR IMPROVEMENTS

GENERAL

American University views the campus site as an integral piece of the University mission and takes advantage of the unique urban setting to provide students, faculty, staff and the local community direct involvement in sustainability initiatives. The Arboretum underscores the dedication to environmental and social responsibility while providing for needed infrastructure. The Project Manager and Designer will:

- Develop site designs that complement the existing campus landscape
- Minimize impact on existing trees and amenities through protection or relocation
- Consult with American University Landscape Architects
- Contain erosion control, including runoff reduction and sediment control
- Include site specific Facilities Management Master Plan requirements
- Consult with Planning and Project Management on ADA requirements

DESIGN CONSIDERATION

The Designer shall make every attempt to utilize products that conform, match or are similar to existing American University (AU) site designs.

Designer shall include sustainable elements.

Selection criteria for exterior site products includes maintenance and upkeep requirements. For example, avoid using fences and gates that require cyclic painting.

Consult the AU Arboretum and Landscape Architects for tree and plant selection.

Designer is to avoid invasive plant materials in species selection.

Confirm pavement markings with University Safety and Security Services for campus consistency.

Contractor will provide a maintenance plan as a submittal prior to installation of plants. Coordination with the Facilities Management Grounds department is required for plant maintenance or replacements during the warranty period.



EXECUTION

The contractor will protect the existing site and restore any damage to the satisfaction of the University. This includes, but is not limited to sidewalks and pavers, existing vegetation and irrigation, roadways, utility poles, drains and covers, and street or informational signs.

Relocate or transplant existing trees, shrubs and other plants per the direction of the project Facilities Management Grounds and the American University Landscape Architects. Design specification and scope of work is to include specific direction on required protection, moving instructions and replanting directions.

Hand watering may be required if the irrigation system is not operable or is not incorporated into the design. Contractor to develop watering schedule respond within 24-hours of notice for extra watering during the warranty period.

Product selections by the Designer not listed herein will be included in the Basis of Design document for Facilities Management Grounds and Landscape Architect to review and comment.

PLANTING IRRIGATION – 32 84 00

Design irrigation system to integrate with existing Rain Bird system. Include one (1) year service including labor and materials for new or renovated irrigation systems.

Irrigation systems are integrated with the existing Rain Bird Irrigation control system and where appropriate the Building Automation System. A CAT6 network data drop is a requirement.

A backflow preventer is required on the irrigation system. Certify backflow preventer not less than one week before Substantial Completion or temporary occupancy whichever comes first. Transmit certificate to Facilities Management via formal project submittal.

New systems require a DC water meter for sewer credit.



TURFS AND GRASSES – 32 92 00

Facilities Management Grounds has an established mowing and maintenance schedule for turf and grass that accommodates the University event schedule. Contractor to incorporate these requirements into service and maintenance plan.

Turf soil preparation shall be verified by Landscape Designer and Grounds staff prior to seeding or installation of sod.

PLANTS - 32 93 00

Landscape designer and Grounds staff shall jointly review and approve bed and container preparation prior to placement of plants.

Plants considered invasive or in obviously poor condition (damaged, diseased, disfigured, et.) will be rejected and replaced at the Contractors expense

Division 32 Exterior Improvements Products

Concrete – Walkways

1. Davis Colors Sandstone #5237, scored as designed

Curbs – High Visibility Areas and Plazas

1. Mount Airy Granite DC street curb

Irrigation System

1. Rain Bird

Pavers – Entrances, Plazas and High Visibility Areas

1. Hanover Presto® Brick Classic Series Matrix # B91763 Tudor Finish, her- ringbone pattern with soldier course border
2. Bluestone Select Blue 2'X3'

Pavers – Walkways Fire Lane

1. EP Henry Coventry Stone 1, Harvest and Dakota mix blend

Subject to compliance with project requirements, acceptable manufacture(s) include, but are not limited to, the following:

1. N/A if product meets Owners Program Requirements (OPR) and design criterion.

END OF DIVISION 32



DIVISION 33 UTILITIES

GENERAL

American University views the campus site as an integral piece of the University mission and Facilities Management (FM) Energy and Engineering takes care to ensure reliability and continuity of needed campus wide services to enable University success in this endeavor. The design of the current campus utility distribution system provides the cost effective needed infrastructure for today's needs and tomorrows anticipated demand. The Project Manager and Designer for new utility work will:

- Consult with FM Energy and Engineering on design and selection
- Include site specific Facilities Management Master Plan requirements
- Protect existing utilities during new work
- Minimize impact of outages for new service tie-in

The designer may include project specific underground utility work in Divisions 22, 23 or 26 provided scope and execution meets the intent of Division 33.

DESIGN CONSIDERATIONS

The Designer shall include life cycle cost including installed price, maintenance and operations, and utility use as selection criteria for major campus infrastructure projects. Include payback criteria for option selection by American University. The university may elect to use the analysis in a more general basis to determine thresholds for using specific material types, installation methods, etc. on a project-by-project basis.

The cost of annual maintenance and upkeep requirements shall be included in the selection criteria for utility products on the distribution system. FM will identify such information during the Owners Project Requirements for incorporation into the Basis of Design. See the control and monitoring, integration, compatibility and similar American University requirements in appropriate system division.

American University does not permit overhead utility distribution. This includes permanent utilities for the Main Campus, East Campus and Washington College of Law. Off-campus buildings on a single site to follow District of Columbia requirements.



The Consultant shall provide a written description of how the entire system is designed to operate. This Basis of Design (BOD) narrative also shall describe how project objectives are being met. It shall be provided in a format that can be easily understood by a layperson, the end user.

The narrative identifies items that specifically meet the Owners Project Requirements (OPR) and the most recent Facilities Management (FM) or department System Master Plan(s) and articulate a rationale for any variance. Changes in the BOD that differ substantially from the original conceptual submission shall be updated prior to issued-for-construction (IFC) documents.

For renovations, the systems selected shall be compatible with the existing building's mechanical systems. The integrity of the basic existing building system shall not be compromised, except where agreed to by the Owner. Work shall be designed and sequenced to minimize impact and interruptions in occupied buildings.

For site work, the Consultant shall indicate all existing underground work such as piping, valves, manholes, electric wiring and telephone, whether new connections are being made or not. Profiles of all piping need to be shown to facilitate coordination with the crossing of other utilities.

EXECUTION

The contractor shall protect existing site and restore any damage to the satisfaction of the University. This includes, but is not limited to sidewalks and pavers, existing vegetation and irrigation, roadways, utility poles, drains and covers, and street or informational signs.

Relocate or transplant existing trees, shrubs and other plants per the direction of the project Facilities Management Grounds and the American University Landscape Architects. Design to include specific direction on required protection, moving instructions and replanting directions. Site and tree protection requirements are project specific.

Product selections by the Designer not listed herein will be included in the Basis of Design document for Facilities Management Energy and Engineering to review, comment and concur.

Contractor shall secure work zone and de-mark per contract documents. Include alternative directions, signs, and road/crowd control in work plan. Submit to Project



Manager prior to start of work for internal American University review, concurrence and campus notification.

The contractor is responsible for any damage stemming from the uncoordinated interruption of existing utilities and building services.

STORMWATER PERMITS

The contractor is responsible for obtaining any required stormwater permits to perform underground utility work. Consultant will provide design drawings to be used to obtain the stormwater permit and will include a minimum of one revised set based upon stormwater permit review comments. Refer to Division 1.

COMMON WORK RESULTS FOR UTILITIES – 33 05 00

Refer to Divisions 22, 23 and 26 for common work results.

Inactive utilities are not to be abandoned unless approved by the Owner. When approved by the Owner, abandoned utilities shall be filled with flowable fill and piping capped or plugged with it or compatible material.

New underground utility vaults shall be precast unless approved otherwise by the Owner. Penetrations shall be made watertight using Linkseal or approved equal. Vaults shall be provided with integral sump, two manway openings and stainless steel ladder(s). Include vaults to scale in utility profile drawings.

Integrity testing and associated fill, flush, passivation or chlorination/ treatment shall be consistent for exterior and interior wet utilities and/or tie-in to campus systems. In no case shall the new work allow untreated hydronic systems to interconnect with campus utilities. See Division 22 Plumbing and Division 23 Mechanical.

Dry utilities shall not be energized until the AU stakeholder (E&E Master Electrician, Office of Technology, or University Safety and Security Services) have confirmed the new work. See Division 26 Electrical.

STORMWATER CONVEYANCE – 33 42 00

Place structures where access by maintenance personnel and equipment will minimize damage to existing site amenities. Consider pedestrian walk paths and repair or service impact duration in final layout.

Pumped systems, not including sump pumps in vaults, require monitoring and alarms to



the Building Automation System as described in Division 25. Heat Trace requirements may also apply.

SUB DRAINAGE – 33 46 00

The Designer should consider and suggest sustainable reuse or avoidance alternatives to discharge volume for American University to receive a DC Water sewer credit.

UTILITIES PRODUCTS AND MANUFACTURERS

Subject to compliance with project requirements, basis-of-design manufacturer(s) (and model number if applicable) shall be:

N/A – Project specific

Subject to compliance with project requirements, acceptable manufacture(s) include, but are not limited to, the following:

N/A – Project specific

Acceptable products include, but are not limited to, the following: Water:

Main - Ductile Iron, C900, Laterals – copper, fused HDPE

Sewer: Main - SDR 26 PVC, Ductile Iron, Laterals – Schedule 40/80 pvc, Ductile Iron

Storm: Double/triple wall HDPE, Sanitite Polypropylene,
Gasketted Reinforced Concrete, Ductile Iron

END OF DIVISION 33



AMERICAN UNIVERSITY
DESIGN STANDARDS
REFERENCES

Appliance	Location	Company	Model	Dimensions	Energy Star?	Finish	Note
Dishwasher	Staff Apartment	GE	GDT580SSFSS	34" x 23.75" x 24"	Yes	Stainless Steel	hidden controls
Dryer	Staff Apartment	Whirlpool	WED72HEDW	31"D x 38.75"H x 27"W	N/A	White	stand alone
Microwave Oven	ADA Staff Apartment	GE Profile	PEB7226SFSS	14" x 24.125" x 19.75"	N/A	Stainless Steel	countertop
Microwave Oven	ADA Student Apartment/McDowell Suites	GE Profile	PEB7226DFWW	14" x 24.125" x 19.75"	N/A	White	2.2 cu ft, countertop
Microwave Oven	Staff Apartment	GE Profile	PVM9179SFSS	16.25" x 29.875" x 15.5"	N/A	Stainless Steel	1.7 cu ft., over-the-range type, w/ convection
Microwave Oven	Student Apartment	GE Profile	PVM9195DFWW	16.5" x 29.75" x 15.5"	N/A	White	1.9 cu ft, over-the-range
Microwave Oven	Traditional Student Lounges	Sharp	R21LVF	16"D x 12.125"H x 20.5"W	No	Stainless Steel	Ordered from Microwave Specialties, Touch pads have braille
Oven & Range	Staff Apartment	GE	JD630SFSS	27" x 28.5", 31.25"	N/A	Stainless Steel	ADA, drop-in type, special cabinet required
Oven & Range	Student Apartment and Lounges	GE	JB450DFWW	47" x 29.875" x 34.675"	N/A	White	Freestanding, ADA, 12 hour automatic shut off
Range Exhaust Hood	ADA Student Apartment	GE	JV347HWW	5.5" x 29.875" x 17.5"	No	White	Convertible- ducted or recirculating, 3 fan speeds
Range Exhaust Hood	Staff Apartment	GE	JVE40STSS	19.5"D x 5.94"H x 29.88"W	Yes	Stainless Steel	
Range Exhaust Hood	Student Apartment	GE	JVE40DTWW	18.88"D x 18"H x 36"W	Yes	White	
Range Exhaust Hood	Student Lounges	GE	JVE40STSS	19.5"D x 5.94"H x 29.88"W	Yes	Stainless Steel	
Refrigerator	Staff Apartment	GE	GDE20GSHSS	66.5" x 29.75" x 34.625"	Yes	Stainless Steel	Bottom freezer, 20.3 cu ft, icemaker
Refrigerator	Student Apartment	GE	GDE20GGHWW	66.5" x 29.75" x 34.625"	Yes	White	Bottom freezer, 20.3 cu ft, icemaker
Television	Student Lounges	Toshiba	50L2400U	8.5"D x 27.6"H x 44.1"W	N/A	Black	LED backlit LCD; 1080p-120Hz
Washer	Staff Apartment	Whirlpool	WFW72HEDW	33.13"D x 38.75"H x 27"W	High-Efficiency	White	stand alone
Washer/Dryer	Staff Apartment	GE	GTUN275EMWW	75.5" x 30.75" x 27"	Yes	White	stacked unit (I think we wanted to switch to non-stackable, though)

The equipment listed above is typical in residence halls. Confirm make and model number is available. Changes or replacements require approval from Housing and Residence Life.

AU Electrical Labeling Color Scheme

Color	Example	Use
white letters on black	Normal power	Standard identification for building systems and equipment
white letters on orange or black letters on orange	Critical power Critical Power	Critical and optional (legally required) emergency power
white letters on red	Emergency power	Life safety systems

Note: Labeling for all equipment should match source of power.

Strategic and Operational Master Plans

Updated January 2023

Master Plan or Study	Department	Contact Information	Area of Responsibility	Name
Arboretum Master Plan	Facilities Management	2Fix@american.edu	Arboretum Manager	Mike Mastroda
Athletic Exterior Site Master Plan 2018	Facilities Management	2Fix@american.edu	Energy & Engineering	Ransom Schutt
Building Automation Master Plan FY18	Facilities Management	2Fix@american.edu	Energy & Engineering	Eddy Peng
Campus Arc Flash Study	Facilities Management	2Fix@american.edu	Energy & Engineering	Carl Spence
Campus Geothermal Study FY10	Facilities Management	2Fix@american.edu	Energy & Engineering	David Osborne
Campus Lighting Study 2000	Facilities Management	2Fix@american.edu	Energy & Engineering	Carl Spence
Campus Plan 2022	Planning and Project Management	fpd@american.edu	Director, Planning	Edna Pate-Cloutier
Campus Wide Water Distribution Survey FY10	Facilities Management	2Fix@american.edu	Energy & Engineering	David Osborne
Commissioning Master Plan 2012	Facilities Management	2Fix@american.edu	Energy & Engineering	David Osborne
Elevator Master Plan FY18 (pending)	Facilities Management	2Fix@american.edu	Facilities Operations	Stephen Kriesten
Exterior Lighting Master Plan	University Safety and Security Services	police@american.edu	AVP, Risk, Safety and Transportation	Daniel Nichols
Fire Alarm Master Plan 2018	Facilities Management	2Fix@american.edu	Energy & Engineering	Carl Spence
Fire Suppression Master Plan FY18 (pending)	Facilities Management	2Fix@american.edu	Energy & Engineering	Carl Spence
Generator Master Plan 2006	Facilities Management	2Fix@american.edu	Energy & Engineering	Carl Spence
Low Voltage Distribution	Facilities Management	2Fix@american.edu	Energy & Engineering	Carl Spence
Medium Voltage Master Plan 2011	Facilities Management	2Fix@american.edu	Energy & Engineering	Carl Spence
Roof Survey 2013	Facilities Management	2Fix@american.edu	Capital Renewal Manager	Darrick Adkins
Sewer Master Plan Mapping and Assessment 2009	Facilities Management	2Fix@american.edu	Energy & Engineering	David Osborne
Sewer Master Plan Report 2009 and 2011	Facilities Management	2Fix@american.edu	Energy & Engineering	David Osborne
Smart Grid Study 2009	Facilities Management	2Fix@american.edu	Energy & Engineering	David Osborne
ADA Survey	Planning and Project Management	fpd@american.edu	Director, Planning	Jonathan McCann
OIT Master Plan	Office of Information Technology	helpdesk@american.edu	Director, OIT Network Operations	Hassan Marvi
AU Strategic Plan (pending)	Planning and Project Management	fpd@american.edu	Director, Planning	Jonathan McCann
Security Master Plan	University Safety and Security Services	police@american.edu	AVP, University Police	Phil Morse
Exterior Lighting Survey	University Safety and Security Services	police@american.edu	AVP, University Police	Phil Morse
Chilled Water	Facilities Management	2Fix@american.edu	Energy & Engineering	Mark Freedman
Domestic Water	Facilities Management	2Fix@american.edu	Energy & Engineering	Mark Freedman

Summary of Changes August 2018

Document Layout and Content Changes

The document title has been renamed [American University Design Standards](#), further emphasizing the importance of planning and owner project requirements. The emphasis throughout has shifted primarily to design information for pre-construction use with formatting that facilitates review of design and project documents for consistency with the Design Standards. Appropriate references to Strategic and Master Plans was added.

The combined manuscript was broken into individual files comprised of documents, divisions, sections, reference, appendix and references. Individual documents (word, excel, pdf) are added, deleted, or edited with less effort and minor visual rework of the portfolio.

The grouping of documents follow design or construction phases for ease of use. The pdf version at www.american.edu/standards is fully indexed.

- i. [Divisions](#) continue to use the CSI format, following MasterSpec December 2017. Key Division areas are broken into [Sections](#). Changes implemented:
 - a. Division 00 Procurement and Contracting requirements is deleted in its entirety. Text directs the user to contact the Purchasing department directly.
 - b. Division 01 General Requirements includes AU specific project implementation, quality assurance and closeout information. These 17 new Sections result from joint FM and PPM work sessions, identified by CSI title in the Appendix.
 - c. Division 02-33 includes the sub-groups for Facility Construction, Facility Services, Site, and Infrastructure. Changes implemented:
 - i. Divisions include general direction on university design requirements.
 - ii. AU required and acceptable manufactures and products are listed by specific item at the end of the Division.
 - iii. Text or information misplaced was moved into the correct document. Clarifying CSI identifying information has been added where appropriate.
 - iv. The unique Division 25 Integrated Automation requirements for integration with the AU building automation system are individually listed into 12 new Sections following accepted controls nomenclature and sectioning
 - v. Division 31 Earthwork and Division 33 Utilities have been added.
- ii. [Appendixes](#) include the Consultants Guide heavily used by Planning and Project Management as a stand-alone document. The Division 1 documents, intended to be used during the project manual development, are included in the Appendix.
- iii. [References](#) have been expanded to address commonly asked questions during the design and construction process.
- iv. [Archives](#) is a new web page link to the prior version referenced in contract documents at date of contract issue. A version and changes log is included.

Summary of 2018 BAS Changes

- A. Section 25 08 00 - Commissioning of Integrated Automation [UPDATED]
- B. Section 25 11 13 – Integrated Automation Network Servers [NEW – derived from 250000]
- C. Section 25 11 16 - Integrated Automation Network Routers, Bridges, Switches, Hubs, and Modems [NEW – derived from 251200]
- D. Section 25 14 13 - Integrated Automation Remote Control Panels [UPDATED – formerly 251400]
- E. Section 25 15 16 - Integrated Automation Software for Control and Monitoring Networks [UPDATED – formerly 251500]
- F. Section 25 35 00 – Integrated Automation Instrumentation Terminal Devices for HVAC [UPDATED]
- G. Section 25 35 13 – Integrated Automation Actuators and Operators [NEW – derived from 253500]
- H. Section 25 35 16 – Integrated Automation Sensors and Transmitters [NEW – derived from 253500]
- I. Section 25 35 19 – Integrated Automation Control Valves [NEW – derived from 253500]
- J. Section 25 35 23 – Integrated Automation Control Dampers [NEW – derived from 253500]
- K. Section 25 55 00 – Integrated Automation Control of HVAC [UPDATED – formerly 250000]
- L. Section 25 55 00.13 – Integrated Automation Control of HVAC – Object Naming Convention [NEW – derivation and expansion of point naming]
- M. Section 25 95 00 – Integrated Automation Control Sequences for HVAC [UPDATED – formerly 259000]

Summary of Changes January 2019

Document Layout and Content Changes

1. Based upon feedback from the AU Design Standards Committee the full version format changed slightly into General Requirements and Technical Requirements.
2. General Requirement documents include the Consultants Guideline and Division 01 Requirements for use during planning and programming by the design team. This required minor wording changes on the Division 01 summary document in the combined pdf version.
3. Technical Requirement documents include construction design related requirements and remain organized using the CSI Master Format division nomenclature. This required minor wording changes on the summary page in the combined pdf version.
4. All references to Appendix were removed. This is now General Requirements.
5. The table of contents was updated to reflect format changes above.
6. The missing Division 25 BAS summary document was inserted and hyperlinked in the single combined document.
7. The AU Strategic and Operational Master Plan reference was updated to include the Exterior LED Master Plan.
8. Under the Technical Requirements subdivided documents tab, Divisions with Sections now are available as both a combined document or as individual documents. The content is the same.
9. Due to staffing changes, the Design Standards Committee member list was updated.
10. Several missing documents we placed in the References tab.
11. The missing summary of 2018 changes to the BAS Division 25 documents was added in Version History. A summary of the January 2019 changes (this document) was added and the version log updated.

Summary of Changes January 2023

Document Layout and Content Changes

1. Based upon feedback from the AU Design Standards Committee the full version format changed the Consultant Guide and all main Divisions.
2. The act of removing redundancy, unnecessary product data and code/compliance data was one of the main focuses.
3. The revision of Division 21 through 26 was also a main focus. This revision ensured that all language reflected the changes made during the LTHW, CHW and Desigo Migration projects.
4. The Consultant Guide was streamlined to avoid sections detailing “due diligence” and basic design and construction processes.
5. Many of the reference documents were edited or removed as they can be found in other areas of the AU document repertoire.



DESIGN STANDARDS VERSION LOG

American University Design Standards		Aug-18		Jan-23			
	Letter	Aug-18		Jan-23			
	Standards Committee Members	Aug-18	Jan-19	Jan-23			
	Table of Contents	Aug-19	Jan-19	Jan-23			
	Preface	Aug-18		Jan-23			
	Forward	Aug-18		Jan-23			
AUDS Technical Requirements Cover		Aug-18	Jan-19	Jan-23			
00	Procurement and Contracting	Aug-18		Jan-23			
01	General Conditions	Aug-18	Jan-19	Jan-23			
02	Existing Conditions	Aug-18		Jan-23			
03	Concrete	Aug-18		Jan-23			
04	Masonry	Aug-18		Jan-23			
05	Metals	Aug-18		Jan-23			
06	Composites, Plastics and Wood	Aug-18		Jan-23			
07	Thermal and Moisture Protection	Aug-18		Jan-23			
08	Openings	Aug-18		Jan-23			
09	Finishes	Aug-18		Jan-23			
10	Specialties	Aug-18		Jan-23			
10 14 10	Mechanical Room Safety Alert Drawings	Aug-18		Jan-23			
11	Equipment	Aug-18		Jan-23			
12	Furnishings	Aug-18		Jan-23			
13	Special Construction	Aug-18		Jan-23			
14	Conveying Systems	Aug-18		Jan-23			
15	Mechanical	Aug-18		Jan-23			
16	Electrical	Aug-18		Jan-23			
21	Fire Suppression	Aug-18		Jan-23			
22	Plumbing	Aug-18		Jan-23			
23	Heating, Ventilating and Air Conditioning	Aug-18		Jan-23			
25	Integrated Automation		Jan-19	Jan-23			
25 00 08	Integrated Automation Commissioning	Aug-18		Jan-23			
25 11 13	Integrated Automation Network Services	Aug-18		Jan-23			



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25 11 16	Network Routers Bridges Switches Hubs and Modems	Aug-18		Jan-23			
25 14 13	Remote Control Panels	Aug-18		Jan-23			
25 15 16	Software For Control and Monitoring Networks	Aug-18		Jan-23			
25 35 00	Instrumentation and Terminal Devices for HVAC	Aug-18		Jan-23			
25 35 12	Actuators and Operators	Aug-18		Jan-23			
25 35 16	Sensors and Transmitters	Aug-18		Jan-23			
25 35 19	Control Valves	Aug-18		Jan-23			
25 55 00	Control of HVAC	Aug-18		Jan-23			
25 55 00.13	Control of _Object Naming Convention	Aug-18		Jan-23			
25 95 00	Control Sequences for HVAC	Aug-18		Jan-23			
26	Electrical	Aug-18		Jan-23			
26 32 1.x	Generators	Aug-18		Jan-23			
26 55 22	LED Lighting	Aug-18	pending	Jan-23			
27	Communications	Aug-18		Jan-23			
28	Electronic Safety and Security	Aug-18		Jan-23			
28 46 21.x	Fire Alarm Systems	Aug-18		Jan-23			
31	Earthwork	Aug-18		Jan-23			
32	Exterior Improvements	Aug-18		Jan-23			
33	Utilities	Aug-18		Jan-23			
AUDS General Requirements Cover		Aug-19	Jan-19	Jan-23			
	Consultants Guide	Aug-18		Jan-23			
	Division 01 Requirements	Aug-18		Jan-23			
01 21 00	Allowances	Aug-18		Jan-23			
01 25 00	Substitution Procedures	Aug-18		Jan-23			
01 25 00a	Substitution Attachment	Aug-18		Jan-23			
01 31 00	Project Management and Coordination	Aug-18		Jan-23			
01 32 00	Construction Progress Documentation	Aug-18		Jan-23			
01 32 33	Photographic Documentation	Aug-18		Jan-23			
01 33 00	Submittal Procedures	Aug-18		Jan-23			
01 40 00	Quality Requirements	Aug-18		Jan-23			
01 42 00	References	Aug-18		Jan-23			
01 50 00	Temporary Facilities and Controls	Aug-18		Jan-23			



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01 60 00	Product Requirements	Aug-18		Jan-23			
01 73 00	Execution	Aug-18		Jan-23			
01 77 00	Closeout Procedures	Aug-18		Jan-23			
01 78 23	Operation and Maintenance Data	Aug-18		Jan-23			
01 78 39	Project Record Documents	Aug-18		Jan-23			
01 91 13	General Commissioning Requirements	Aug-18		Jan-23			
References		Aug-18		Jan-23			
	AU Electrical Labeling Color Scheme	Aug-18		Jan-23			
	AU Site Design Standards	Aug-18		Jan-23			
	Appliance and Electronic Standard (residence halls)		Jan-19	Jan-23			
	BAS Drawings and Control Sequences		Jan-19	Jan-23			
	Cx Customization Guide		Jan-19	Jan-23			
	Equipment Numbering Scheme	Aug-18		Jan-23			
	FM Equipment Asset ID Schemas	Aug-18		Jan-23			
	FM Facilities Designations	Aug-18		Jan-23			
	FM Piping Color Code	Aug-18		Jan-23			
	FM Space Needs	Aug-18		Jan-23			
	Process for Activities or Interruptions	Aug-18		Jan-23			
	Space Numbering Guidelines	Aug-18		Jan-23			
	Strategic and Operational Master Plans	Aug-18	Jan-19	Jan-23			