FAA-STD-032
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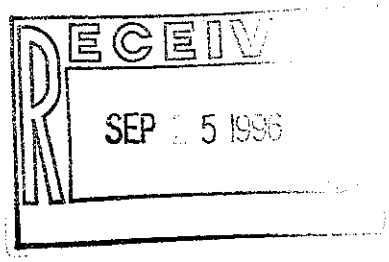

U.S. Department of Transportation

Federal Aviation Administration

Standard

DESIGN STANDARDS

FOR NATIONAL AIRSPACE SYSTEM FACILITIES

Contents

List of Tables

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1. SCOPE

1.1 Scope. This standard defines the design requirements that shall be incorporated into designs of new National Airspace System (NAS) facilities and modifications to existing NAS facilities.

1.2 Purpose. This standard provides guidelines for the design of all new facilities and modernization and expansion of existing NAS facilities including buildings, structures, support equipment, surrounding grounds and site utilities. Specific technical requirements for these facilities will be defined in the subsystem or project specification and in the facility development specification for each subsystem or project. This standard is primarily for use in the development of national standard designs and may be used for site adaptation by Federal Aviation Administration (FAA) Washington in preparation of the facilities requirements portions of the NAS project specifications and shall be used by architects and engineers in the design of new facilities and modifications of existing NAS facilities. Criteria for MCF facilities is currently being developed.

2. APPLICABLE DOCUMENTS

2.1 Government documents. The latest government reference documents (as of this standard revision date) are listed below. However, the documents noted in the text are without alpha revision designations. The documents of the issue in effect on date of invitation for bids or request for proposal, form a part of this standard to the extent specified herein. In the event of conflict between the documents referenced herein and the contents of this standard, the contents of this standard shall be considered a superseding requirement.

SPECIFICATIONS:

FAA

FAA-E-113d	Poles, Wood, Treated
FAA-C-1217e	Electrical Work, FAA Facility
FAA-C-1244	Installation of Engine Generators and Fuel Tanks
FAA-C-1391b	Installation and Splicing of Underground Cable
FAA-E-2013c	Cable, Electrical, Power, Exterior, 600 to 15,000 v
FAA-E-2042b	Cable, Electrical Control, Exterior
FAA-E-2065	Fences
FAA-E-2072b	Cable, Telephone, Exterior
FAA-G-2100f	Electronic Equipment, General Requirements
FAA-E-2171c	Cable, Coaxial, Armored, M17/6 - RG-11
FAA-E-2204c	Diesel Engine Generator Sets, 5 KW to 300 KW
FAA-C-2256	Temperature and Humidity Control Equipment
FAA-D-2494b	Technical Instruction Book Manuscript: Electronic, Electrical and Mechanical Equipment, Requirements for Preparation of Manuscript and Production of Books

FAA-E-2619a Cable, Coaxial, RG-35 B/U

FAA-E-2840 Uninterruptible Power System, Critical Power Centers and Harmonic Current Traps for ARTCC/ACF Power Systems

FAA-E-2849 Diesel Engine Generator, 675 KW Continuous Standby for ARTCC/ACF Power System

STANDARDS:

FAA

FAA-STD-002c Facilities Engineering Drawing Preparation
FAA-STD-004a Criteria for Selection and Installation of Fire Extinguishers
FAA-STD-005d Preparation of Specification Documents
FAA-STD-019b Lightning Protection, Grounding, Bonding and Shielding Requirements for Facilities
FAA-STD-020 Transient Protection, Grounding and Shielding Requirements for Equipment
FAA-STD-033 Design Standards for Energy Management in NAS Facilities

FAA ORDERS:

1050.1d	Policies and Procedures for Considering Environmental Impacts
1050.10b	Prevention, Control and Abatement of Environmental Pollution at FAA Facilities
1050.14a	Polychlorinated Biphenyls (PCBs) in the NAS
1040.15	Underground storage tanks at FAA facilities
1365.1	Department of Transportation Graphic Standards
1600.6c	Protection of Agency Property
1600.54b	Security of FAA Automatic Data Processing Systems and Facilities
1800.2	Airway Facilities Service Life Cycle Cost Studies
3900.19a	Occupational Safety and Health
4660.1	Real Property Handbook
4660.2	Accessibility of FAA Buildings to the Physically Handicapped
5050.4a	Airport Environmental Handbook
6000.13	Potentially Adverse Effects of Construction on Air Traffic Control and Air Navigation (ATC&N) Facilities
6030.20e	Electrical Power Policy
6480.7c	Airport Traffic Control Tower and Terminal Radar Approach Control Facility Design
6650.8	Airport Fiber-optic Design Guidelines
6930.25A	Maintenance of Structures and Buildings
6950.2c	Electric Power Policy Implementation at National Airspace System Facilities
6950.15b	ARTCC Critical Load Circuits and Configuration
6950.19	Practice and Procedures for Lighting Protection, Grounding, Bonding and Shielding
6950.23a	Cable Loop Systems at Airport Facilities
6950.27	Short Circuit Analysis and Protective Device Coordination Study
6960.1c	Sanitary Systems in FAA Facilities
6980.24a	Battery Theory and Selection Guidelines
6980.26	Battery Backup Power Systems - Theory and Selection Guidelines

FAA Management Documents

NAS-MD-790A Maintenance Processor Subsystems to Remote Monitoring Subsystems and RemoteMonitoring Subsystem Concentrators Interface Control Document
NAS-MD-793 Detailed RMS Functional Definitions

Department of the Air Force Manuals

AFM 88-3 Seismic Design for Buildings, Chapter 13
AFM 88-29 Engineering Weather Data

OTHER DOCUMENTS:

Environmental Protection Agency (EPA)

National Environmental Policy Act

FAA Advisory Circulars

AC 70/7460-1c Obstruction Marking and Lighting

AC 150/5370-2 Operational Safety on Airports During Construction

Federal Register

10 CFR 435 Energy Conservation Voluntary Performance Standard for New Buildings: Mandatory for Federal Buildings

41 CFR 101-19 Construction and Alteration of Public Buildings: Appendix A to Subpart 101-19.6,
Uniform Federal Accessibility Standards (Fed-STD-795)

Public Law 90-480; 82 STAT. 718

Americans with Disabilities Act (ADA)

Occupational Safety and Health Administration

Requirements and Standards

Office of Management and Budget

Circular A-94 Discount Rates to be Used in Evaluating Time-Distributed Costs and Benefits

Copies of specifications, standards drawings and publications required by suppliers in connection with specified procurement functions should be obtained from the procuring activity or as directed by the FAA Program Manager.

2.2 Non-government documents. The following documents of the issue, in effect on date of invitation for bids or request for proposal, form a part of this standard to the extent specified herein. In the event of conflict between the documents referenced herein and the contents of this standard, the contents of this standard shall be considered a superseding requirement.

STANDARDS AND CODES:

American Association of State Highway and Transportation Officials (AASHTO)

American Concrete Institute (ACI)

ACI 318 Building Code Requirements for Reinforced Concrete

American Conference of Governmental Industrial Hygienists (ACGIH)

Manual on Industrial Ventilation

American Institute of Steel Construction (AISC)

Code of Standard Practice for Steel Buildings and Bridges

American National Standards Institute (ANSI)

A17.1 Safety Code for Elevators and Escalators
C2 National Electrical Safety Code

American Society of Civil Engineers (ASCE)

ASCE 7 Minimum Design Loads for Buildings and Other Structures

American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE)

ASHRAE Handbook HVAC Applications Volume
ASHRAE Handbook Equipment Refrigeration Volume
ASHRAE Handbook Fundamentals Volume
ASHRAE Handbook HVAC Systems and Equipment Volume

ASHRAE 52 Methods of Testing Air Cleaning Devices Used in General Ventilation for Removing Particulate Matter
ASHRAE 62 Ventilation for Acceptable Indoor Air Quality

American Society for Testing and Materials (ASTM)

American Welding Society (AWS)

Architectural Aluminum Manufacturers' Association (AAMA)

Building Officials and Code Administrators International, Inc. (BOCA)

The BOCA Basic/National Building Code
The BOCA Basic/National Fire Prevention Code
The BOCA Basic/National Mechanical Code
The BOCA Basic/National Plumbing Code

Electronics Industries Association/Telecommunications Industries Association (EIA/TIA)

Standard 568	Commercial Building Telecommuinications Cabling Standard
Standard 569	Commercial Building Standard for Telecommunication Pathways and Spaces
Standard 606	Administrative Standard for the Telecommunication Infrastructure of Commercial Buildings

Illuminating Engineering Society (IES)

Lighting Handbook, Reference and Application Volume

Institute of Electrical and Electronics Engineers (IEEE)

IEEE STD-1100
IEEE STD-142-1991

International Association of Plumbing and Mechanical Officials (IAPMO)

Uniform Plumbing Code (UPC)

International Conference of Building Officials

Uniform Building Code (UBC) Volumes I, II and III
Uniform Fire Code
Uniform Mechanical Code (UMC)

National Association of Plumbing - Heating - Cooling Contractors

National Standard Plumbing Code

National Electrical Manufacturers Association (NEMA)

National Fire Protection Association (NFPA)

Fire Protection Handbook

National Fire Codes (NFC)
National Life Safety Code
National Electrical Code (NEC)

National Forest Products Association (NFPA)

National Design Specifications for Stress Grade Lumber and Its Fastenings

Sheet Metal and Air Conditioning Contractors' National Association (SMACNA)

Architectural Sheet Metal Manual
Seismic Restraint Manual: Guidelines for Mechanical Equipment

HVAC Systems Commissioning Manual

Southern Building Code Congress International, Inc. (SBCCI)

Standard Building Code
Standard Mechanical Code
Standard Plumbing Code
Standard Fire Protection Code

Underwriters Laboratory Inc. (UL)

Technical society and technical association specifications and standards are generally available for reference from libraries. They are also distributed among technical groups and using Federal agencies.

3. REQUIREMENTS

3.1 General. Except when otherwise stated herein and in addition to specifically cited codes and regulations, all designs shall be in accordance with the nationally recognized codes and regulations for uniformity of design and construction. National standard designs shall be in conformance with the most current revision of the Uniform Building Code, Uniform Fire Code, Uniform Mechanical Code and Uniform Plumbing Code. In those instances where local codes or regulations are more stringent than, or are in conflict with nationally recognized codes and regulations, those local codes or regulations shall be used. The requirements (as defined 6.2.2) of this standard are not necessarily imposed on the designs of all physical facilities (as defined 6.2.2). The applicability of this standard is defined in the engineering requirement, task order or system specification. Design goals shall provide flexibility to accommodate expected variations in system configurations as individual FAA mission equipment (as defined in 6.2.2) is installed, modified, removed or expanded during the NAS

upgrade process. Design of buildings or space therein for housing of air traffic control, navigation, communication and radar facilities and their supporting elements are usually National Standard Designs contained in drawings, specifications and directives prepared and distributed by NAS Implementation Service. Technical space design is governed primarily by the amount, type and configuration of FAA mission equipment to be installed, the protection and security of both this equipment and personnel, the number and type of operating positions, and the related maintenance, administrative, training, general office and storage activities. Other factors, such as economy of construction using value engineering concepts, design life, equipment investment by the Government, environmental conditions, aesthetic and safety requirements shall also be considered.

3.1.1 Deviation from design standards. Regions may change or adapt nationally prescribed space design standards when necessary to meet specific site requirements. The changes shall be minimal and limited to the requirements of local building regulations and codes and other local factors. Local building materials (brick, metal panels, concrete block, etc.) may be substituted for the material specified in the standards when such substitutions are economically and technically justified for specific areas.

3.1.2 Environmental and safety considerations. All FAA projects shall ensure that they comply with all state and federal environmental regulations and with federal occupational safety and health regulations. All FAA projects shall also comply with the National Environmental Policy Act and ~~E~~environmental and safety considerations shall be in accordance with FAA Order 5050.4.

3.1.2.1 Environmental impact. Except for exempted facilities and categorical exclusions, the beneficial and adverse environmental effects of the construction and operation of facilities shall be evaluated at the earliest practical stage in the design of FAA facilities. Exempted facilities and categorical exclusions will be determined by the FAA on a case-by-case basis in accordance with FAA Order 1050.1 and 5050.4. All considerations of environmental impact shall be in accordance with FAA Orders 1050.1 and 5050.4.

3.1.2.2 Prevention, control and abatement of environmental pollution. Prevention, control and abatement of environmental pollution at FAA facilities shall be in accordance with FAA Orders 1050.10 and 4660.1.

3.1.3 Energy conservation and management. NAS Plan projects involving energy consumption shall conform to FAA-STD-033.

3.1.4 Construction scheduling. When the size or complexity of the design warrants, the specification shall include the requirement that a Critical Path Method (CPM) network schedule be prepared. for each project by the construction contractor. The CPM shall show the order in which a construction contractor could reasonably be expected to accomplish the construction work within the allotted time period, including procurement of materials, availability of support equipment (as defined 6.2.2), plant or facilities and specific requirement dates for delivery of Government furnished equipment. Schedules shall provide a plan for staging construction and equipment installation and testing to avoid interference with assigned NAS operations and conform to FAA Order 6000.13.

3.1.4.1 Constructibility. A construction period of optimum duration shall be determined for each assigned project. All facilities shall be designed to ensure constructibility with minimum operational disruption when existing operational facilities are involved. All construction constraints shall be evaluated. Items to be evaluated include climatic conditions, existing construction, materials availability, utility services or the need for temporary utility services and other unique site conditions affecting construction.

3.1.4.2 Continuity of operation. All site investigations and construction activities shall be planned to minimize any disruption to air traffic control operations; safety and efficiency of the Air Traffic Control (ATC) System shall in no way be jeopardized. Any necessary disruptions shall be planned and coordinated with Air Traffic Service and accomplished during periods of low or no air traffic activity. ATC continuity, safety and efficiency shall be given prime consideration throughout all phases of design and construction.

3.1.4.3 Construction noise levels. Construction noise levels shall be controlled and reduced and shall be in accordance with FAA Order 1050.1. Where local noise regulations and ordinances applicable to the specific physical location are more stringent than FAA Order 1050.1, the noise level in those areas shall conform to the local noise regulations and ordinances.

3.1.4.3.1 Noise control. Prior to commencing any physical facility construction activity in the vicinity of the air traffic control operations, suitable measures shall be taken to ensure that the construction activity noise level magnitude will not constitute a hazard to flight safety. Noises resulting from construction activities in the proximity of communications operating positions shall be controlled or suitably dampered to ensure that noises are not transmitted and do not interfere with other transmission or reception and that excessive noise is not a nuisance to the surrounding community.

3.1.4.3.2 Standards. Due to the diverse types of construction noise and the variables in air/ground or ground/air communications environments and operations, the solutions to the noise problems shall be determined on an individual basis. To aid in the solution of these problems, the following guidance shall be applied as appropriate to meet the requirements of this standard.

a. Schedule construction operations at periods of low or non-existing air traffic activity.
b. Isolate construction areas with acoustical drapes or curtains or with temporary acoustical walls, ceilings and floor as required to reduce sound transmission to acceptable levels.
c. Limit construction operations in air/ground communication areas to the installation function only. Perform fabrication, assembly (as defined 6.2.2) etc. functions elsewhere.
d. Utilize construction methods that result in minimum noise levels.

Where these methods do not provide sufficient acoustical isolation, coordinate with FAA Operations to utilize noise canceling microphones and headsets and "muff-type" earphones or use alternate operating positions located away from the construction area if they are available.

3.1.4.4 Construction safety on airports. All construction on airports shall comply with safety provisions as identified in Advisory Circular 150/5370-2. Each bidding document shall incorporate a section on safety on airports which, as a minimum, shall contain the provisions as outlined in

Appendix 1 of FAA AC 150/5370-2. A safety plan shall be developed for approval by the airport operators and users for any necessary deviations from the criteria. On Federal Aviation Regulation Part 139, Certificated Airports, the safety inspector shall be involved in all stages of construction activity planning.

3.1.5 Construction contract specifications. Construction contract specifications shall be prepared in accordance with FAA-STD-005.

3.1.6 Construction contract drawings. Construction contract drawings shall be prepared in accordance with FAA-STD-002.

3.1.7 Cost estimating. Construction cost estimates shall be prepared for all NAS projects. Estimates shall be provided during the various stages of design, shall be of sufficient detail to accomplish the intended purpose and shall be expressed in physical units of measure and applicable unit costs. Additive items shall be shown as special features. All critical cost determining assumptions shall be stated.

3.1.7.1 Engineering cost estimate. Estimates shall be prepared on standardized estimating forms approved by FAA. Standard estimates shall be prepared for both national standard and site specific designs. Estimates for site specific designs shall be based upon the national standard design estimate to the greatest possible extent. Quantity takeoff work sheets shall be prepared to readily identify location of items, allow easy modification and assist in construction contract negotiations and change orders.

3.1.7.2 Design implementation cost control. Continuing construction cost analyses of the design shall be maintained during all phases of the design program. Construction cost analysis shall include approved escalation cost factors. An approved National Standard Cost Index shall be appropriately used in preparation of construction project cost estimates. Should any analysis indicate that the stipulated cost for any given specific project is being exceeded as a result of adhering to the design requirements specified herein, suitable design alternatives shall be proposed to meet these requirements. Where specified, a cost control reporting procedure shall be established in order to provide FAA management with timely cost trends. The procedure shall provide FAA management with the following:

a. Estimated total cost of project;
b. Monthly updating as design program matures;
c. Revised program cost projections due to changed requirements or cost savings programs.
d. Value Engineering Cost savings i.e., alternate design solutions, etc.

3.1.8 Reliability, maintainability and availability. The intent of the FAA is to procure equipment for NAS facilities that provides the highest obtainable reliability consistent with life cycle cost evaluations. The procured equipment, systems and subsystems shall be reliable and readily maintainable to minimize support cost (parts and labor) over the useful life of the equipment. Reliability shall be enhanced by the use of redundant standby systems or equipment by sizing

equipment with additional capacity and by providing reliable sources of power to the systems or equipment. Designs shall attempt to achieve and maintain the following goals:

a. To maintain a consistently high level of system reliability throughout the service life of the equipment;
b. To achieve a regular schedule (if possible) between maintenance actions (corrective and preventive) of not less than every 90 days per system at attended sites or 90 days between visits at unattended sites;
c. To eliminate chronic maintenance actions.

3.1.9 Economic analyses. Design for NAS Plan facilities shall consider the analysis of the costs to acquire, maintain, operate and repair a building or structure (as defined 6.2.2) over the designated economic life (as defined in 6.2.2). Economic analyses (simple payback or life cycle cost) shall be performed for all major systems and items of equipment. Economic analysis for energy-consuming facilities systems or equipment shall be in accordance with FAA-STD-033. All other economic analysis methods shall be in accordance with FAA Order 1800.2. The use of discount rates shall be in accordance with Office of Management and Budget Circular A-94.

3.1.9.1 Value criteria for facility designs. FAA policy requires selection of design types for which the construction of the facility will be economical, taking into consideration the entire life cycle cost of the facility. The designs shall be in accordance with accepted good engineering and architectural practices. Function shall be given foremost consideration, but consideration shall also be given to appearance so that results will be compatible with local environment. Regions have the responsibility and authority for site adapting the National Standard Designs to local conditions as necessary and for application of value engineering during supplemental design and during construction.

3.1.9.2 Facility economic life. Unless otherwise specified, the economic life of shall be in accordance with Appendix I. Where no figure is provided, the economic life shall be twenty (20) years.

3.1.10 Provisions for the physically handicapped. Unless otherwise specified, or directed by FAA, all facilities shall be designed, constructed or altered so they are accessible to, and usable by, the physically handicapped. The FAA will identify the specific work areas and job tasks of the physically handicapped.

3.1.10.1 Applicability. Except as otherwise stated herein, these requirements shall apply to the following facilities:

a. Constructed or modified by or on behalf of the FAA;
b. Leased in whole or in part by the FAA after 12 August 1968 after construction or alteration in accordance with plans and specifications of the FAA;
c. Financed in whole or in part by a grant or a loan made by the FAA after 12 August 1968 if such facility is subject to standards for design, construction or alteration issued under authority of the law authorizing such grant or loan.

3.1.10.2 Governing authority. Provisions for the physically handicapped shall be in accordance with FAA Orders 4660.1 and 4660.2.

3.1.10.3 Mandatory accommodations. Mandatory accommodations for the physically handicapped shall be included in the design and construction of new facilities and modifications to existing facilities. They shall include, but not be limited to, the following:

a. Stairs
b. Doors
c. Elevators
d. Toilets
e. Entrances
f. Drinking fountains
g. Floors (surfaces and slope deviations)
h. Telephones
i. Curbs
j. Parking areas
k. Vending machine areas
l. Convenience outlets
m. Light switches
n. Thermostat locations
o. Emergency alarms
p. Signage
q. Walkways and ramps

3.1.10.4 Standard. Implementation of FAA policy regarding provisions for the physically handicapped shall be in accordance with the Uniform Federal Accessibility Standards (UFAS) Federal Register 41 CFR 101-19.

3.1.10.5 Exemptions. All facilities shall accommodate the physically handicapped except for those exempted facilities or portions of facilities which are unmanned or must be manned entirely with personnel without physical handicaps. Exempted facilities will be identified by the FAA.

3.1.11 Human Factors Considerations. Human factors shall be evaluated in the design and construction of the project in order to obtain optimum performance of the individual in the most cost effective manner. The factors that shall be considered include, but shall not be limited to, the proper operational environment, personnel safety and user acceptance. Human-environment trade-off studies shall be performed in the concept phase to ensure that the human resource capability requirements established are both realistic and cost effective.

3.1.12 Occupational safety and health. All designs, construction, on-site design and construction activities and equipment operation shall be in accordance with the applicable requirements of the Occupational Safety and Health Administration (OSHA) and FAA Order 3900.19.

3.1.13 Design data summary handbook. Unless otherwise directed, a design data summary handbook shall be presented for review at the interim and final stages of the design effort per FAA-ER-220-001. The handbook shall contain the following information:

a. Code analysis;
b. Design assumptions and parameters for each design discipline;
c. Test reports and findings;
d. Design calculations for each design discipline;
e. A verification matrix (as defined in 6.2.2) in the introductory pages of the Handbook.

3.1.14 Mechanical and electrical systems handbook. Unless otherwise directed, a handbook covering the description and operation of the mechanical and electrical systems shall be prepared by the architect or engineer (A/E) for each facility. The handbook shall provide a total systems overview of the operation and interface of each mechanical and electrical system. This shall be provided through the use of schematics, one line diagrams and written descriptions. In addition, it shall include the manufacturers' catalogs, installation and operation instructions, routine maintenance required, photographic cuts and diagrams of the equipment used as the basis of the design.

3.1.15 Mechanical and electrical systems instruction book. A system or subsystem description, operations and maintenance instruction book manuscript shall be prepared for major and complex systems by the A/E when specified in the engineering requirement or task order. This instruction book shall provide a physical and functional description of the mechanical and electrical systems, subsystems and interfaces. The instruction book shall be companion to and supplement the design drawings and specifications to provide concise explanations of design intent with regard to system or subsystem configuration, sequence and modes of operation, capabilities and limitations. The instruction book shall be organized and include material in accordance with requirements of FAA-D-2494. Specific system operation and maintenance data on the brands and models of installed equipment which were not available until after construction shall be added to the instruction book by the construction contractor.

3.1.16 Provisions for Remote Maintenance Monitoring System (RMMS). Provisions for RMMS shall be in accordance with NAS-MD-790 and NAS-MD-793. Where specified, architectural, mechanical and electrical systems and equipment which have a direct effect upon the proper and reliable functioning of and the security of flight operations equipment shall have provisions for remote maintenance monitoring. The systems and equipment shall include, but shall not be limited to, door locks and other building security systems, environmental control and fire protection systems and critical and essential electrical systems. Building security systems shall have the capability of sounding an alarm and reporting unauthorized entry, fire alarms, HVAC failures, critical and essential electrical failures via the RMMS. Existing FAA hardware, software, and firmware shall be used to interface with all systems. There shall not be unique or stand-alone reuirement needed to monitor NAS equipment.

3.1.17 FAA signage. FAA signage shall be in accordance with FAA Order 1365.1.

3.1.18 ATCT and TRACON facility design. ATCT and TRACON facility design shall be in accordance with the latest revision of FAA Order 6480.7.

3.2 Civil engineering. This section provides basic civil engineering standards for design and construction of NAS physical facilities.

3.2.1 Site survey. This section defines the minimum requirements for a boundary and topographic site survey for design and construction of NAS facilities.

3.2.1.1 General. The survey shall include all field work necessary, including review of pertinent public records, to accurately determine the property lines and existing physical conditions of the site, establish bench marks, monument markers and record the information and the required data on a topographic and boundary survey drawing. Survey record drawings shall be prepared at a scale of not less than one inch equals 20 feet and a contour interval of 1 foot.

3.2.1.2 Topographic survey. The topographic survey shall graphically represent the site, including location of existing structures, utilities, cables and the extent of trees and vegetation on the site. Except for densely wooded sites or sites larger than 1/4 acre, all trees six (6) inches or more in diameter shall be identified and located. For densely wooded sites or sites larger than 1/4 acre, the tree line shall be noted and labeled as wooded or densely wooded, etc., as appropriate. Topographic information shall include an area outside the limits of the site boundary to provide adequate information to blend the site grading into the surrounding terrain.

3.2.1.3 Boundary survey.

3.2.1.3.1 Property description. The survey drawing shall contain or be supplemented by a legal description of the property.

3.2.1.3.2 Bench mark. A bench mark referenced to any established datum shall be marked on a permanent object adjacent to the site and be clearly located and described on the survey drawings. All bench marks shall be referenced to mean sea level or national reference.

3.2.1.3.3 Boundary lines. Boundary lines of the site shall be shown in bearings and distances.

3.2.1.3.4 Property corners. All corners of the site and other boundary line intersections not previously marked shall be identified and marked. The location and description of each marker shall be shown on the survey drawings.

3.2.1.3.5 Reference points. All markers shall be referenced to semi-permanent points of a conspicuous nature such as existing buildings, runway intersections, bridge abutments etc., where possible. The location and description of each reference point shall be shown on the survey drawings.

3.2.1.3.6 Easements. The location description and dimensions of all easements of record as well as rights-of-way required for FAA construction of communication and control lines, power transmission lines, access roads, sewer, water or fuel lines, etc. shall be shown on survey drawings.

3.2.1.4 Coordination of controls.

3.2.1.4.1 Horizontal controls. Horizontal controls shall be tied to federal and state coordinate systems if such systems are accessible. Otherwise, they shall be tied to the local control system.

3.2.1.4.2 Vertical controls. Vertical controls shall be tied to local control datum. All local control datum used for design and construction of NAS facilities shall reference mean sea level.

3.2.1.4.3 Accuracy requirement of control surveys. Surveys shall be of an accuracy accepted locally for legal property descriptions.

3.2.2 Subsurface exploration.

3.2.2.1 Foundation design and site adaptations. Foundation design and site adaptations shall be based on soil exploration and analyses performed by a soils engineer licensed in the state where the facility is located.

3.2.2.2 Exploration and testing. A site exploration shall be performed. The requirements for field and laboratory work shall be coordinated with the proposed site layout and facility design to ensure that the data obtained will be sufficient to complete the necessary civil and structural design of the facility.

3.2.2.3 Soil reports. Unless otherwise stated in the engineering requirement or task order, a report containing an evaluation of site conditions and definitive recommendations for foundation and pavement designs shall be prepared. The report shall include all data collected in the field exploration and laboratory testing programs. The report shall also include data on the soil resistivity in order to determine the requirements for corrosion protection.

3.2.3 Site development.

3.2.3.1 General. The main objective of site development and design for new and modified existing NAS physical facilities shall be as follows:

a. Obtain an integrated relationship of all elements of new and modified NAS physical facilities (such as structures, land-use areas, utilities, roads and parking areas) to each other and the overall site to provide functional operational efficiency and construction economy;
b. Recognize and take full advantage of physical site characteristics to avoid excessive expenditures for such items as grading, foundations, drainage, roads, utilities and subsequent ground maintenance.
c. Avoid potential development and security conflicts by considering adjacent existing and future land use i.e., planned developments.

3.2.3.2 Earthwork and grading. Site earthwork and grading design shall be planned with the following principal objectives:

a. Preservation of the natural character of the site by minimum disturbance of existing ground forms and meeting satisfactory ground levels at existing objects to be saved;
b. Optimum on-site balance of cut and fill;
c. Avoidance of earth banks requiring costly erosion control measures;
d. Disposal of surface run-off from site without erosion and directing the surface run-off toward existing water course or to existing drainage systems;
e. Avoidance of changing the existing water course.

3.2.3.3 Erosion and sedimentation control. Erosion and sedimentation control measures shall be in accordance with applicable county and state approved standards. Erosion and sediment control measures shall be provided in order to ensure that the environmental stability of the construction area is not degraded. Local practice and conditions shall dictate the type of erosion and sedimentation control to be used at a given location. The major objectives of erosion and sedimentation control shall be the following:

a. Keeping disturbed areas to a minimum;
b. Stabilizing disturbed areas as soon as practical;
c. Maintain low velocities for storm water runoff;
d. Protecting disturbed areas from erosion due to storm water runoff;
e. Retaining sediments within the site.

3.2.4 Site utilities. Provision of utilities essential (as defined in 6.2.2) to efficient operation, and of adequate size to serve future requirements, shall be evaluated in the early planning stages to avoid conflicts in the design and layout of the various utility lines. Planning of utility lines shall take into consideration items such as the following:

a. Utility easements or rights-of-way;
b. Location, size and elevations of sanitary sewers, storm drains or open drainage, drain inlets and manholes;
c. Location, elevation and size of water supply, gas heat transmission mains and electrical services;
d. Location and size of street lighting and telephone lines, including pole and manhole locations;
e. Location of fire alarm call boxes.

3.2.4.1 General. Design and construction of site utilities shall be in accordance with the codes and regulations applicable in the region of the project site. The following shall be the minimum standard requirement for NAS facilities:

3.2.4.1.1 Appearance. Careful consideration shall be given to the location of poles, transformers, vaults, meters, pressure reducing station piping and valving, and other utility lines to avoid detracting from building appearance. Complete underground utility service shall be evaluated for all major buildings on an installation where above ground or overhead service would conflict with the desired architectural character or where required to eliminate electromagnetic interference (EMI) or prevent obstructions on airport surfaces.

3.2.4.1.2 Underground lines. Underground lines shall be located so that minimum effort and cost would be required for excavation when required for maintenance. Location of all types of underground utility lines under roads, sidewalks, parking lots, paved terraces and other paved areas shall be avoided to the greatest extent possible. Underground utility lines, mains and conduits shall be located at the minimum depth necessary and shall be located in ducts when economically feasible. All underground lines shall be marked on the surface with adequate numbers of concrete

markers at turns and 300 feet maximum intervals and by a continuous strip of yellow or red plastic tape buried 12 inches below surface.

3.2.4.1.3 Electrical. Every effort shall be made to place electrical distribution and telephone lines underground. Where economic or technical reasons require overhead construction, electrical distribution lines shall be located where practicable along streets or roads to avoid the use of separate poles for street lights.

3.2.4.1.4 Water distribution and sanitary sewer lines. Water distribution and sanitary sewer lines shall be located along easements for the shortest run. Where practical, consideration shall be given to locating water and sewage lines along streets or roads or designated utility strips.

3.2.4.1.5 Telephone lines and signal cables. For economy, telephone lines and signal cables shall be carried on the same poles. Underground installation of telephone lines and signal cables is preferred, including installation in manholes and handholds, shall be in accordance with FAA-C-1391.

3.2.4.2 Storm drainage. The facility site shall be protected against damage from storm and surface runoff with consideration given to the damaging effect of storms more severe than the design storm. The storm drainage system, including gutters, drain, inlets and culverts, shall be designed to carry the anticipated runoff, including runoff from melting snow, and inlets shall be provided where necessary to intercept surface flow. Development of undeveloped areas may have a noticeable effect on installation drainage facilities; major alterations or extensions to storm sewers and drainage channels may be required due to the location and design of new facilities. Careful consideration shall be given to protect the environment. An oil/water separator shall be used on site to contain oil spills or vehicle cleaining residues.

3.2.4.3 Sanitary systems.

3.2.4.3.1 General. All sanitary wastes generated at NAS facilities shall be transmitted and discharged into an existing sewage system or into an on-site treatment system. The Environmental Protection Agency (EPA) requires that a permit be obtained for each facility with a sewage treatment system that discharges effluent beyond the property line. This permit defines the required condition of the treated effluent and may vary from site to site.

3.2.4.3.2 Sewage disposal system. The type of sewage disposal system used will depend upon site conditions and economic analyses. The most economical and practical system shall be provided. The sewage disposal system shall be compatible with toilet facilities in 3.3.4.7 and portable toilets in 3.5.4.11.

3.2.4.3.2.1 Septic tank system. Septic tank systems shall be used where sewage discharge capacity supports their use in the event that connection to an existing sanitary sewer system or connection to or the development of an on-site treatment system is not feasible. The septic tank system shall be in accordance with state and local health standards.

3.2.4.3.2.2 Aerobic system. Where economically and environmentally advantageous, aerobic sewage disposal system may be used in lieu of the septic tank system.

3.2.4.4 Water supply system. The water system shall supply the needs for domestic, industrial and fire fighting purposes of the facility. Whenever possible, pressurized treated water shall be purchased from nearby public or private sources. Water sources must meet all EPA requirements.

3.2.4.4.1 Domestic water requirements criteria. Domestic potable water shall be supplied under the following condition as minimum requirements.

a. At facilities having conventional flush toilet systems as defined in 3.5.4;

3.2.4.4.2 Water sources. Water sources shall be selected from the following options.

3.2.4.4.2.1 Purchased water supply.

a. Nearby public utility shall supply water under pressure via water lines and control valve.
b. Water tanker truck shall provide water when a public or ground water supply source is not available.
c. When purchased or ground water supplies are not available or not feasible, then bottled water service shall be provided, or FAA personnel shall be required to supply their own drinking water.

3.2.4.4.2.2 Ground water supply systems. Ground water supply systems from springs or driven, bored, or drilled water wells shall be used to provide potable water to facilities not having access to public water system. Qualitative standards shall be in accordance with EPA standards.

3.2.4.4.2.3 Surface water supply system. Surface water supply systems which collect rain water runoff by gravity into concrete cisterns shall be used in lieu of purchased or ground water where economically more feasible and where there is sufficient quantity of rainfall to warrant the use of these systems. Water treatment shall be in accordance with EPA standards.

3.2.4.4.2.4 Water well pumps. Water well pumps shall be designed to operate at least five years without maintenance. Pumps shall be self-priming and shall be equipped with protective devices to ensure reliability.

3.2.4.4.2.5 Water treatment systems. Water treatment shall be provided for all non-purchased sources of water. The water treatment system shall include chlorination, filtration and softening as required to produce the required quantity and quality of acceptable water.

3.2.5 Vehicular and pedestrian access.

3.2.5.1 Access roads or street systems. Final siting and layout of access road and street systems shall be approved by FAA.

3.2.5.1.1 Access roads. Access roads with turn around areas shall be provided to all FAA facilities or installations where a road is considered to be the best means of ingress and egress. Determination of need shall be based on frequency of use, travel time and comparative costs. Where these access roads are on airports and intersect or terminate at paved runways or taxiways, the initial 300 feet adjacent to the runway or taxiway shall be paved. The number of access roads within the runway primary shall be kept to a minimum. At no time shall an access road be constructed parallel to a runway closer than 200 feet edge to edge and, when parallel to a taxiway, 100 feet edge to edge.

3.2.5.1.2 Street systems. Streets within the project area, where applicable, shall provide convenient and safe access for deliveries, collection, fire protection, maintenance and repair and other essential services.

3.2.5.2 Road construction. All roads shall be of the most economical type that will provide satisfactory and safe transportation of personnel, equipment and material in the types of weather and climatic conditions normally encountered at the location.

3.2.5.3 Criteria for design. Roadway widths, geometry, gradients, site-distances and intersections shall be in accordance with state and local requirements.

3.2.5.4 Vehicle parking. Vehicle parking shall be in accordance with FAA Order 4660.1.

3.2.5.4.1 General. It is FAA practice to provide necessary parking accommodations concurrent with the acquisition of a new physical facility.

3.2.5.4.2 Official vehicle parking. Parking accommodations shall be at or near FAA facilities for all official vehicles required for the proper functioning of the FAA at that location.

3.2.5.4.3 Visitor parking. Parking accommodations at or near FAA facilities shall be provided for visitors based on the results of site specific surveys and security requirements.

3.2.5.4.4 Employee parking. Essential employee parking accommodations shall be provided at or as close as practical to the FAA facility.

3.2.5.4.5 Parking for the physically handicapped. Parking for the physically handicapped shall be provided where applicable. Number of spaces shall be per Uniform Federal Accessibility Standards (UFAS) Federal register 41 CFR 101-19 requirements.

3.2.5.4.6 Motor vehicle heater receptacles. Motor vehicle heater receptacles shall be provided in each parking lot space at locations designated by the FAA, in areas located in heating (winter) Zones I and II (Table II) or otherwise in areas where automobile tank or engine block heaters are installed in automobiles and similar vehicles. Receptacles shall be minimum National Electrical Manufacturers Association (NEMA) standard 20 amp Ground Fault Interruption (GFI) weatherproof type.

3.2.5.5 Walks. The walkway system shall be designed to provide convenient and safe pedestrian access and circulation within the project area and shall be accessible by the physically handicapped where applicable.

3.2.6 Fencing. Fencing shall be in accordance with FAA-E-2065. Grounding provisions shall be in accordance with FAA-STD-019.

3.3 Architecture. This section provides basic architectural standards for design and construction of NAS facilities. The intent is to provide the NAS with facilities that are efficient, reliable and economical to operate and maintain.

3.3.1 General architectural design considerations. FAA national standard designs shall comply with the Uniform Building Code, Uniform Building Code Standards and Uniform Fire Code. Seismic design for national standard designs shall be in accordance to ASCE 7, whereas Av shall not be less than 0.1 and Seismic Hazard Exposure Group III. All site adapted architectural design shall comply with recognized national, standard or uniform codes and standards applicable to the specific facility location. Recognized codes and standards for site adapted designs include the following:

a. The BOCA National Building Code
b. Fire Protection Handbook
c. National Fire Codes
d. Standard Building Code
e. Uniform Building Code
f. Uniform Fire Code
g. Uniform Federal Accessibility Standards

3.3.1.1 Site planning. Site planning and the locations of facilities may be predetermined by the airport master plan or by an airport layout plan. However, the ultimate responsibility for the development of the site shall rest with the architect and engineers with final approval by FAA. Site planning and development shall be in accordance with FAA Order 4660.1.

3.3.1.2 Landscaping. Planting of trees, shrubs and ground cover for aesthetic, ecological and environmental purposes shall be included as an integral part of the design. Landscape design for large sites with difficult topography and environmental problems shall be performed by a qualified professional landscape architect.

3.3.1.3 Future expansion. Future expansion of new facilities shall be taken into consideration at the initial planning stage. Designs for expansion of existing buildings shall ensure minimum disruption and interference to the facilities operations during construction activities. Any design approach for expanding existing buildings shall be formulated after an on-site building survey has been completed. The architectural character of the existing building, construction and age of the facility shall be evaluated.

3.3.2 Organization of interior spaces. Organization of interior spaces shall be in accordance with FAA Order 4660.1. Administrative and extraordinary technical requirements will be provided to the

A/E by the FAA. The functional requirements of the facility, with emphasis on efficiency, economy and flexibility of the layout of the interior spaces, shall be evaluated. Whenever electric heat is used at a major facility, adequate space shall be provided to accommodate gas and oil fired heating equipment as alternative sources of heat.

3.3.3 Architectural acoustics. Control of both internal and external sound sources shall be evaluated in the design. Provide maximum allowable sound level (in dba) for various facility functional areas. This is the level the A/E shall design to so as to allow sufficient noise cushion to accommodate the noise generated by electronic equipment and still maintain a comfortable acoustical work environment. When and where possible, the orientation of the building and the room arrangements within the building shall be planned to reduce noise penetration to the spaces. Where buildings are located in close proximity to an airport, special consideration to reduce aircraft noise transmission to the building shall be evaluated early in the design phase. Generally two types of sound control are required:

a. Sound attenuation for control of disturbance from high energy noise levels produced by aircraft engines, engine generators and mechanical equipment;
b. Acoustical control for minimizing disturbances from intrusive speech and other noises and ensuring a measure of privacy for the conduct of business functions.

3.3.4 Construction systems.

3.3.4.1 Framing. The selection and design of the framing system shall be based upon economical considerations of the functional, architectural and structural requirements. The selection of the framing system may be influenced by:

a. Availability of materials;
b. Local labor and construction practices;
c. Mandatory standard drawings and specifications for certain types of NAS buildings;
d. Criteria and recommendations for design of structure in typhoon, hurricane and other high wind areas;
e. Seismic considerations.

3.3.4.2 Walls. Exterior wall construction materials for buildings shall be selected on the basis of architectural appearance, energy conservation, low maintenance, durability and, where appropriate, noise reduction and compatibility with existing nearby buildings. Aluminum window frames and window wall systems shall conform to applicable standards of the Architectural Aluminum Manufacturers' Association (AAMA).

3.3.4.3 Floors. Primary considerations shall be strength, fire resistance and economy. The design and construction of the floor system shall be such that its integrity and that of the equipment placed on it is not diminished during a typical earthquake anticipated to occur in the seismic zone upon which the design is based. The floor system may also be influenced by:

a. Flexibility in regard to future expansion;

b. Floor depth, both structural and access;
c. Sound and vibration transmission;
d. Suitability of the floor structure to surface finishes;
e. Routing of utilities;
f. Appearance, with respect to exposed undersides;
g. Electrostatic discharge (ESD).
h. Performance as an electrical grounding surface.

3.3.4.3.1 Foundation and slab-on-grade floors. Design considerations of foundation and slab-on-grade floors shall include the results of the subsurface exploration, the site physical characteristics and location of site utilities.

3.3.4.4 Roofs. Roofs shall have a useful life of at least the economic life of the facility, but not less than twenty (20) years.

3.3.4.5 Pre-engineered buildings. Selection of building type shall based on economy and suitability to satisfy space requirements, such as clear span, clear height and area. Performance standards shall not be reduced below those necessary for similar buildings designed for conventional construction. Special emphasis shall be given to the effects of wind, hurricanes and salt laden air and corrosive atmospheric conditions. Criteria for varying climates shall be applied to the design of pre-engineered buildings as specified in this standard.

3.3.4.6 Mobile facilities and systems. Mobile air traffic control, navigation and communications systems are installed in their own special structures or trailers. Land and site requirements for mobile facilities and systems will be provided by the FAA.

3.3.4.7 Toilet facilities. Toilet facilities shall be provided at FAA facilities in accordance with FAA Order 6960.1.

3.3.5 Electrostatic discharge control. The design of walls and floors for designated ESD controlled areas shall be in accordance with FAA-STD-019-IEEE/ANSI and military practices and policies.

3.3.6 Finishes. Interior and exterior finishes shall be compatible with those of the existing facility and the architectural scheme of the nearby facilities. Finishes shall be low maintenance materials selected on the basis of anticipated use, life cycle cost impact, fire and safety requirements and suitability for the environment. In general, decor standards shall be in accordance with FAA Order 4660.1. Finishes for airport traffic control towers (ATCT) and terminal radar approach control facilities (TRACON) shall be in accordance with FAA Order 6480.7.

3.3.7 Architectural sheet metal. Architectural sheet metal such as roof drainage, gravel stops, facia, flashings, copings, expansion joints, metal roofs, skylights, louvers, sunshades, metal decking etc. shall be in accordance with Sheet Metal and Air Conditioning Contractor's National Association (SMACNA) Architectural Sheet Metal Manual.

3.3.8 Building security systems. Except for fire protection, building security systems shall be in accordance with FAA Orders 1600.6B and 1600.54. Physical security measures are required to ensure reliable operation of the NAS at both manned and unmanned sites. Security requirements shall be incorporated into planning and design for NAS facilities to meet the following goals:

a. Protect personnel, data and information, equipment and property;
b. Prevent unauthorized entry into NAS facilities;
c. Control authorized entry;
d. Protect sensitive data, information and areas;
e. Protect and minimize damage from espionage, sabotage and other deliberate acts intended to disrupt normal operation.
f. Accessibility to remote facilities is possible without leaving vehicle.

3.3.9 Elevators. Elevators, both passengers and freight, shall be in accordance with American National Standards Institute ANSI A17.1 and The Uniform Federal Accessibility Standards.

3.3.10 Obstruction marking. Obstruction marking shall be provided in accordance with FAA AC 70/7460-1.

3.4 Structural engineering. This section provides basic structural engineering standards for designs of all new and modified NAS facilities. The intent is to provide the NAS with a building system that is efficient and economical to construct and to maintain.

3.4.1 General structural design considerations. Structural loads on FAA National Standard Designs shall comply with the Uniform Building Code, and Uniform Fire Code and shall not be less than specified in Minimum Design Loads for Buildings and other Structures, American Society of Civil Engineers Standard ASCE 7. Except as modified herein, all site adapted structural designs shall comply with recognized national, standard or uniform codes and standards applicable to the specific facility location. Recognized codes and standards for site adapted designs include the following:

a. The BOCA National Building Code
b. Fire Protection Handbook
c. National Fire Codes
d. Standard Building Code
e. Uniform Building Code
f. Uniform Fire Code

Except as modified herein, all designs, in addition, shall be in accordance with applicable standards of the following:

g. American National Standards Institute
h. American Institute of Steel Construction
i. American Welding Society
j. American Forest and Paper Association
k. American Concrete Institute

3.4.2 Coordination. The structural system layout shall be properly coordinated with all other building systems and functions.

3.4.3 Selection of system and materials. Structural systems and materials shall be suitable for FAA facilities, capable of carrying the required loads satisfying fire protection requirements and compatible with architectural and functional needs. In choosing materials for specific projects, the following shall be evaluated:

a. Site environment including climate, subsurface condition, accessibility, wind velocity and seismic readings activity;
b. Skill and experience of prospective contractors;
c. Design life and life cycle costs;
d. Availability of labor and materials;
e. Feasibility of prefabricating major structural elements.

3.4.3.1 Concrete. Concrete structural members shall be proportioned in accordance with American Concrete Institute (ACI) Codes, Specifications, and Standards.

3.4.3.2 Structural steel. Structural steel shall be in accordance with the specifications and standards of the American Institute of Steel Construction (AISC).

3.4.3.3 Wood. Wood for structural purposes shall be in accordance with National Forest and Paper Association, National Design Specifications. (NFPA).

3.4.4 Seismic loads. Seismic design shall be in accordance with the ASCE 7. For national standard designs, Affective Peak Velocity-Related Acceleration (Av) shall be not less than 0.1 and Seismic Hazard Exposure Group III. In any major modification or expansion of existing buildings, structural investigations shall include an analysis of the impact on the seismic response of the existing structure. Seismic load considerations shall include, but not be limited to, the following.

3.4.4.1 Structural and Siting considerations. Structures shall not be sited over active geologic faults, in areas of instability subject to landslides, on unstable slopes or where soil liquefaction is likely to occur.

3.4.4.2 Configuration considerations. Irregular structures in the plan or vertical sense shall not be used when Affective Peak Velocity-Related Acceleration (Av) equals or exceeds 0.15.

3.4.4.3 Performance requirements. For each specific project the importance of post-earthquake operations shall be determined.

3.4.5 Wind. Wind design shall be in accordance with the ASCE 7. All national standard designs shall be designed for a basic minimum wind speed of 80 MPH.

3.4.6 Structural integrity. All buildings and structural systems shall possess general structural integrity. Structural elements shall be so arranged and connected to provide continuity and energy-

absorbing capacity to withstand the effects of local abnormal loadings without collapse of the entire structure.

3.4.7 Calculations. All structural calculations shall be provided in an orderly manner in the Design Data Summary Handbook and shall clearly show that the structures can adequately support the design loadings. The calculations shall clearly show consideration for conditions such as, but not limited to, soft ground, stability, settlement, impact, waterproofing and fire resistance in the design of the buildings and structures. Where the structural system cannot be analyzed on a rational basis, acceptability of the load carrying capacity of the system shall be determined by suitable load or model tests.

3.4.8 Special inspections. The testing and inspection of the materials of construction used structurally in buildings or structures shall conform to the requirements specified in the UBC.

3.5 Mechanical engineering. This section provides basic engineering standards for design of all heating, ventilating, air conditioning (HVAC) systems and plumbing to be installed in FAA facilities. FAA national standard designs shall comply with the Uniform Building Code, Uniform Mechanical Code, Uniform Plumbing Code and Uniform Fire Code. All site adapted mechanical engineering design shall comply with recognized national, standard or uniform codes and standards applicable to the specific facility location. The requirements of the following Codes shall be complied with where applicable. In the event of a conflict between Codes, the conflict shall be brought to the attention of the appropriate FAA representative for resolution. It is the responsibility of the design engineer to verify all state and local codes that are applicable and to comply with those codes in addition to the following:

a. The BOCA National Mechanical Code
b. The BOCA National Plumbing Code
c. The BOCA National Fire Prevention Code
d. National Fire Protection Association (NFPA) Fire Codes and Life Safety Code
e. National Standard Plumbing Code
f. The Southern Standard Mechanical Code
g. The Southern Standard Plumbing Code
h. The Southern Standard Building Code
i. The Southern Standard Fire Prevention Code
j. The National Electrical Code

Except as modified herein, all designs of mechanical systems, in addition, shall be in accordance with the following:

k. American Conference of Governmental and Industrial Hygienists (ACGIH)
l. American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE) Handbooks: Fundamentals; Refrigeration; HVAC Applications; and HVAC Systems and Equipment.
m. American National Standards Institute (ANSI)

n. American Society of Civil Engineers, Minimum Design Loads for Buildings and Other Structures (ASCE 7)
o. The American Society for Testing and Materials (ASTM)
p. Sheet Metal and Air Conditioning Contractors National Association (SMACNA)
q. National Environmental Balancing Bureau
r. FAA-STD-033 - Design Standards for Energy Management in NAS Facilities

3.5.1 General mechanical design consideration. The selection of major mechanical systems and equipment shall be justified by life cycle analysis or if system selection is dictated by the facility operations, justification shall be submitted to the appropriate FAA representative for approval. Selection of systems and equipment shall be of current proven technology. All electrical systems and equipment that are an integral part of a mechanical system shall be in accordance with 3.6 of this Standard. The mechanical systems shall provide a controlled environment to maintain stability, reliability and maximum life of electronic equipment installed in the facility by reducing thermal strain and particulate contamination. The systems shall also provide a healthy and acceptable environment for operating and maintenance personnel by maintaining appropriate temperature and humidity control and reducing particulate contamination, noise and excess air velocities within the facility. Mechanical design for ATCT/TRACON/ARTS facilities shall be in accordance with the latest version of FAA Order 6480.7.

3.5.2 Temperature and humidity systems. This section establishes requirements governing design and installation criteria of temperature and humidity control systems in FAA facilities. Criteria for determining qualifying facilities are included.

3.5.2.1 Objectives.

a. Provide controlled environment to maintain stability, reliability and life of electronic equipment by reducing thermal strain and particulate contamination.
b. Maintain an acceptable working environment for maintenance and operating personnel by providing proper levels of temperature and humidity and reducing particulate contamination, odor, noise and excessive air velocities.

3.5.2.1.1 Qualifying criteria for providing temperature and humidity control equipment and systems. The selection of temperature and humidity control equipment and systems shall be provided in accordance with the following criteria. Facilities are divided into three groups based upon equipment to be installed in the facility, occupancy requirements, exterior climatic conditions and required interior environmental conditions.

3.5.2.1.1.1 Group One. Major facilities shall be provided with heating and air conditioning systems regardless of geographic location and exterior ambient environmental conditions. However, humidification equipment shall be provided where justification for this equipment is based upon one of the following:

a. There is a history of humidity-related problems at the existing facility;

b. There is a history of humidity-related problems at other similar FAA facilities housing similar operations.

Approval for providing humidification equipment is required from the appropriate FAA representative. The recommendation for installation of humidification equipment shall be submitted to FAA by the design engineer and shall include appropriate justification to include an estimate of anticipated operating costs.

3.5.2.1.1.2 Group Two. Facilities (not covered in group one above) shall be provided with heating equipment. Humidification equipment shall be provided in accordance with Paragraph 3.5.2.1.1.1. above. However, when either of the following conditions is encountered, air conditioning equipment shall be provided.

a. Personnel are employed in the area for a total of forty (40) hours per week, and the inside effective temperature meets or exceeds eighty (80) degrees Fahrenheit for twenty-five (25) days in any one year. Any number of occurrences during a single day in which this effective temperature is reached shall be regarded as only a single day towards this total. An 80°F effective temperature is met or exceeded with any combination of dry bulb and associated wet bulb temperature as indicated in the following table.

TABLE I

80°F Effective Temperature Combinations

°F Dry Bulb	°F Wet Bulb
76.5	76.5
77	74.5 or above
78	72.5 " "
79	69.6 " "
80	66.5 " "
81	63.5 " "
82	60.5 " "
83	56.5 " "
84	53 " "
85° and above with any Wet Bulb	

b. Equipment manufacturer recommendations prohibit operation of equipment in environment where the outside temperature is 93F or higher for 100 or more hours per year.

3.5.2.1.1.3 Group three. Facilities (not covered above) shall be provided with heating equipment. Humidification equipment shall be provided in accordance with Paragraph 3.5.2.1.1.1. However, when either of the following conditions is encountered, air conditioning equipment shall be provided.

a. The facility is located in an area where the outside environment contains dust, smoke, a corrosive atmosphere or noxious odors to such an extent that, without air conditioning, the

resulting indoor environment will have a serious adverse effect (as determined by the appropriate FAA representative) on the operation or maintenance of equipment or the health and well being of personnel.

b. Station records indicate that a health hazard exists or that there has been significant malfunctioning or deterioration of equipment due to temperature or humidity extremes or variations.

In addition, approval for providing air conditioning equipment in these two special cases is required from the FAA and will be based on a case-by-case study which demonstrates that the benefits derived will fully justify the installation and operational costs. It is the responsibility of the design engineer to provide justification to the appropriate FAA representative for review and approval.

3.5.2.2 Design Criteria

3.5.2.2.1 Interior environment design criteria. The interior environments design conditions shall be as indicated below for the various conditioned spaces. Special interior environmental conditions for extraordinary applications will be provided by the appropriate FAA representative. Values for temperature and humidity listed herein shall be for the design and selection of equipment. Setting of setpoints in the field may differ from those listed herein, and shall be in accordance with applicable FAA Orders.

3.5.2.2.1.1 Standard summer and winter temperature/humidity conditions. The standards for unoccupied spaces shall apply to occupied spaces whenever the space is to be unoccupied for a period of eight hours or more. Gradual changes between occupied and unoccupied temperature/ and humidity conditions may be required in order that to insure that equipment performance is not affected.

3.5.2.2.1.1.1 Design Temperatures for air traffic control, radar, communications and electronic equipment areas.

3.5.2.2.1.1.1.1 At ARTCCs.

	Temp (^{O}F)	IRH
Winter	73 $\pm$ 2	30-55
Summer	73 $\pm$ 2	30-55

3.5.2.2.1.1.1.2 At other FAA facilities. Except for certain facilities referenced below, the internal environmental conditions of air traffic control, radar, communications and equipment areas shall be:

	Unoccupied		Occupied	
	Temp (^{O}F)	IRH	Temp (^{O}F)	IRH
Winter	55 $\pm$ 3	35-60	70 $\pm$ 3	35-60

Summer	85 ± 3		35-60	75 ± 3	35-60

The building space interior environment of the following facilities shall be maintained at 65°F (winter) and 78°F 75°F (summer) regardless of building occupancy status.

a. Automated Radar Terminal System: ARTS I, II, III, IIIA, IIIE, TPX-42.
b. Airport Surveillance Radar: ASR-4, 5, 6, 7, 8, 9.
c. Air Route Surveillance Radar: ARSR-3, 4.
d. Instrument Landing System (ILS)P: All Type 55, Mark III, AN/GRN-27.
e. Waveguide Glide Slope.
f. Radar Microwave Line Repeater: All types.
g. Air Traffic Control Beacon Interrogator (ATCBI): Beacon only.
h. Weather Radar Facilities (Tower, NEXRAD).
i. NAVAID Facilities (VOR, DME, TACAN).
j. Communication Facilities (RTR, RCAG).
k. Other facilities as identified by FAA.

Unless otherwise indicated, at unmanned facilities located in areas of high humidity, the air conditioning systems shall be designed to provide the interior temperatures required by the equipment installed within the facility and to provide a maximum relative humidity within the facility of 60% RH.

3.5.2.2.1.1.2 Design Temperatures for Air traffic control automated data processing equipment spaces.

3.5.2.2.1.1.2.1 At ARTCCs.

	Temp (°F)	%RH
Winter	73 ± 2	35-60
Summer	73 ± 2	35-60

3.5.2.2.1.1.2.2 At other FAA facilities. The interior environments of air traffic control automated data processing equipment spaces shall be the same as for air traffic control, radar, communications and electronic areas at these facilities.

3.5.2.2.1.1.3 Administrative areas, offices and living quarters.

3.5.2.2.1.1.3.1 At ARTCCs.

	Occupied	
		Temp (°F)
Winter	75 ± 3	

Summer	75 ± 3

3.5.2.2.1.1.3.2 At other FAA facilities.

	Unoccupied Temp (°F)	Occupied Temp (°F)
Winter	55 ± 3	75 ± 3
Summer	-	75 ± 3

3.5.2.2.1.1.4 Electric service room or transformer vault. The electric service room or transformer vault shall be mechanically ventilated. The ventilation system shall be designed for 10°F rise over outside air ambient temperature and shall not exceed the rated maximum ambient temperature of equipment in the space.

3.5.2.2.1.1.5 Power Conditioning System (PCS) for UPS battery room space temperature. The UPS battery room shall be mechanically ventilated and heated. The space temperature shall be 65° minimum and 10°F rise over ambient summer temperature not to exceed 104°F and shall not exceed the rated maximum ambient temperature of equipment in the space.

3.5.2.2.1.1.6 PCS UPS room temperature. The UPS room temperature shall be from 65°F up to 10°F above outside air temperature, but not over 104°F and shall not exceed the rated maximum ambient temperature of equipment in the space.

3.5.2.2.1.1.7 Mechanical, electrical and engine generator room.

	Unoccupied Temp (°F)	Occupied Temp (°F)
Winter	50 min	65 min
Summer	Ambient +10°	Ambient +10°

Summer design temperatures shall exceed 104°F and the rated maximum ambient temperature of equipment in the space.

3.5.2.2.1.1.8 Kitchens.

	Unoccupied Temp (°F)	Occupied Temp (°F)
Winter	55 min	70 min
Summer	-	85 max

3.5.2.2.1.2 Human occupancy factors. Human occupancy factors will be defined by the system specification, engineering requirement or task order.

3.5.2.2.2 Exterior design conditions. At individual locations and for site adaptation of National Standard Designs, exterior design conditions shall be determined in accordance with ASHRAE Handbook, Fundamentals. For locations not covered by ASHRAE Handbook, exterior design conditions shall be in accordance with AFM 88-29. Records of temperature and humidity occurrence durations are available from the National Oceanic and Atmospheric Administration, Environmental Data Service and the United States Air Force Environmental Technical Applications Center. At locations where temperature and humidity occurrence duration records are not available, the records of the two nearest places of similar elevation, bracketing the location in question, which are available shall be used by interpolation. On-site temperature and humidity reading records may be used when available for approval by the appropriate FAA representative.

3.5.2.2.1 Climatic zones (as defined in 6.2.2). For multiple shelter and total package procurements and National Standard Designs, heating and air conditioning shall be provided with the equipment sized to the appropriate combinations of summer and winter climatic zones listed in Table II below.

Table II
Summer and Winter Climatic Zones

Summer Climatic Zones
(Air Conditioning)

Zone	Temperature
A	95° - 100°F db[1] 75° - 80°F wb[2]
B	95° - 100°F db 70° - 75°F wb
C	90° - 95°F db 70° - 80°F wb
D	90° - 95°F db 70° - 75°F wb
E	85° - 90°F db 75° - 80°F wb

1 db - dry bulb temperature
2 wb - wet bulb temperature

Winter Climatic Zones
(Heating)

Zone	Temperature
I	Below -20°F db
II	-20°F to 0°F db
III	0°F to +20°F db
IV	+20°F to +40°F db
V	Above +40°F db

Special consideration should be given to those locations where the design temperatures exceed 100°F dry bulb and/or 80°F wet bulb.

3.5.3 Mechanical HVAC system and equipment selection criteria. All critical facilities shall have dual HAVC units and shall be capable of heating or cooling the facility independently. The mechanical HVAC system and equipment selection shall be in accordance with the ASHRAE Fundamentals, Refrigeration, HVAC Applications, HVAC System and Equipment Handbooks, applicable Codes and the following criteria:

3.5.3.1 HVAC system and equipment life cycle cost (LCC) analysis. Major HVAC systems that are designed for FAA facilities shall be selected based upon a LCC analysis. This analysis shall compare at least three different types of HVAC systems and the system with the lowest LCC shall be selected. Parameters for the LCC analysis shall be approved by the appropriate FAA representative. Where specific facility operational requirements dictate, the HVAC system may be selected without justification through life cycle analysis, however justification for system selection shall be submitted to the appropriate FAA representative for approval.

For FAA facilities that are in excess of 150,000 square feet, consideration shall be given to designing a central plant heating and cooling facility. The design engineer shall prepare a life cycle cost analysis as described above that compares incremental HVAC equipment to a central plant heating and cooling facility. The system with the LCC cost shall be selected.

Where specific facility operational requirements dictate, the HVAC system may be selected without justification through life cycle cost analysis, however justification for system selection shall be submitted to the appropriate FAA representative for approval.

3.5.3.2 Heating and cooling load analysis. HVAC load analysis shall be in accordance with ASHRAE Handbook - Fundamentals. Major HVAC systems that are designed for FAA facilities shall be sized to satisfy heating and cooling load capacities based upon a computerized facility heating and cooling load analysis equal to Trane Trace or the Carrier HAP HVAC Load Analysis Software Program

3.5.3.3 Ventilation. Facilities with and without air conditioning shall be designed to provide natural outdoor air or forced ventilation in accordance with criteria outlined in the ASHRAE Handbooks - Fundamentals and HVAC Applications and as required by the applicable Codes. Ventilation for acceptable indoor air quality shall be designed to satisfy the requirements of ASHRAE Standard 62. Where ventilation is provided for space temperature maintenance, the ventilation air volume shall be calculated to a maximum temperature of 10^{o}F above the outside summer design temperature but not to exceed 104^{o} F. Where air conditioning is provided in addition to ventilation fans, fan control shall be interlocked to shut down air conditioners to prevent simultaneous operation. Fan shall operate only upon failure of air conditioning to operate and when the outside air temperature is sufficiently low enough that cooling can be provided by the ventilation fan.

3.5.3.3.1 Industrial ventilation. Ventilation for industrial purposes and process areas such as carpenter shops, maintenance shops, engine-generator rooms and other similar spaces shall be in accordance with the ACGIH Manual on Industrial Ventilation. Battery room ventilation rate shall be determined on the basis of the rate and quantity of hydrogen gas evolving from the batteries. Ventilation shall be adequate to maintain hydrogen gas concentration at 25% or less than the lower explosive limit (LEL). Exhaust ventilation shall be used to maintain battery room at a lower pressure than adjacent spaces. Exhaust air shall not be recirculated.

3.5.3.4 Air filtration. Air cleaning systems shall conform to recommendations of ASHRAE Handbook, - HVAC Systems and Equipment and the appropriate SMACNA duct design and construction manuals. Air cleaning systems and equipment shall be provided to minimize entry of contaminants into the ventilated or conditioned space or otherwise remove airborne contaminants from the space. Air filter efficiencies shall be approved by the appropriate FAA representative.

3.5.3.4.1 High quality air filtration. High quality air filtration systems and equipment shall be used in heating, ventilating and air conditioning (HVAC) equipment serving critical areas. Pre-filtration shall normally be provided and shall be two-inch thick glass fiber disposable filters. In addition, disposable medium to high-efficiency final filters shall be used to maintain acceptable air quality. Standard filters shall have a minimum of 30% efficiency based upon ASHRAE Standard 52, atmospheric dust spot efficiency test. Electrostatic air filters may be used when justified by life cycle cost versus benefit analysis. Charcoal filters may be used in addition to particular filters to maintain acceptable air quality for human occupancy in areas such as airports and industrial environments which are subjected to gaseous contaminants. Control of gaseous contaminants shall conform to ASHRAE Handbook, - HVAC Systems and Equipment.

3.5.3.5 Duct design and pipe sizing. Ductwork system design and piping system sizing shall be in accordance with ASHRAE Handbook, - Fundamentals. Ductwork shall be designed to minimize the need for internally fiberglass lined ducts.

3.5.3.6 Temperature and humidity controls. Temperature and humidity controls shall be designed in accordance with ASHRAE Handbook, - HVAC Applications and this standard.

3.5.3.7 Sound and Vibration Control. Sound and vibration control shall be in accordance with ASHRAE Handbook, - HVAC Applications.

3.5.3.8 Air and water system balance. Air and water system shall be in accordance with the ASHRAE HVAC Applications.

3.5.3.9 Equipment selection criteria. Equipment selection criteria shall be determined on a case-by-case basis for the facility requiring the temperature or humidity control equipment. In addition, the following criteria shall be applicable for the specific facility type.

3.5.3.9.1 Field and remote facilities. Temperature and humidity control systems and equipment shall be in accordance with FAA-C-2256.

3.5.3.9.1.1 Control action. For smaller facilities, single stage, ON-OFF cooling cycle shall be used. The equipment fan shall run continuously to circulate room air during the period of time that the equipment is operating or when there is a need for circulating air. The air temperature leaving the cooling equipment shall be 12 to 20°F lower than the room return air entering the equipment. When heat is required, heaters will cycle on demand as sensed by space thermostats, and air conditioners and vent fans shall be de-energized. Excessive cycling of equipment during partial loading conditions shall be minimized via staging of heating and cooling as applicable.

3.5.3.9.1.2 Multiple units. When one unit cannot prevent a temperature rise above a set point, two (or more) units shall be provided and operated as required to maintain proper space conditions. The thermostat settings of the secondary (backup) unit shall be 1 to 2°F higher than the primary unit, and the tertiary unit 1 to 2°F above the secondary, etc.

3.5.3.9.1.3 Combination systems. Combination systems which combine at least two of the multiple-refrigerant circuit units operating through a common control panel shall be considered as an option to multiple units where economically feasible.

3.5.3.9.1.4 Heat pumps. The use of heat pumps shall be considered wherever the heating system is likely to require electric resistive heating coils.

3.5.3.9.1.5 Auxiliary fan. Except at facilities equipped with air conditioners having a separate evaporator-ventilating unit or redundant air conditioners, all electronic facilities shall be provided with one or more auxiliary fans. The auxiliary fans shall provide emergency ventilation only. When the space temperature exceeds the prescribed set point by 10°F, or by any specified lower temperature difference, the fan(s) shall operate until normal space temperature is achieved. Fan control shall be equipped with an override relay to lock out heaters and air conditioners.

3.5.3.9.1.6 Chillers. Equipment selection for chillers must also take into account factors such as the Ozone Depletion Potential, Global Warming Potential, efficiency and ease of maintenance and support.

3.5.3.9.2 Larger FAA facilities. Larger FAA facilities shall be provided with central plant heating and cooling. Heat may be provided via air handling units by a heating water (hydronic) system, steam or electric resistance coils. Cooling may be provided via air handling units by chilled water or direct

expansion systems. HVAC Systems for ATCT/TRACON/ARTS facilities shall be in accordance with FAA Order 6480.7.

3.5.3.9.3 HVAC systems power sources. HVAC equipment serving FAA facilities shall be provided with electrical power as follows:

a. Where facility power is provided via three electrical buses, i.e. critical, essential and building service buses~~,~~. all HVAC systems serving critical equipment shall be connected to the essential bus. All other HVAC equipment shall be powered from the building service bus. Standby engine generator power is provided to the essential and critical buses.
b. Where power is provided by two buses, i.e., critical and building service, HVAC systems serving critical equipment shall be connected to a portion of the building service bus which is connected to the standby power bus.
c. Where multiple HVAC units serve critical equipment, provide power fed from separate distribution panels such that, if a distribution panel is lost or down for repair, all capacity of HVAC is not lost.

3.5.3.9.3.1 HVAC systems power sources for ATCT/TRACON/ARTS facilities. HVAC system power sources for ATCT/TRACON/ARTS facilities shall be in accordance with FAA Order 6480.7.

3.5.3.9.3.2 HVAC systems power sources for ARTCCs. The power sources for HVAC systems serving critical electronic mission equipment in ARTCCs shall be in accordance with FAA Order 6950.15.

3.5.3.9.4 System and equipment redundancy and capacity growth. Redundant (back-up) systems and equipment, such as extra pumps, air handling units, ventilation fans, window air conditioning units, etc., shall be provided when required by the system specification, engineering requirement or task order and when required to maintain FAA mission equipment reliability, availability and maintainability. The redundant equipment shall be sized with adequate capacity to handle satisfy normal facility HVAC load. Multiple HVAC units shall be provided for critical spaces such that the installed capacity, including redundant units, is kept to a minimum. Larger equipment, such as cooling towers, chillers and boilers, shall be sized with extra capacity where justified and in accordance with good engineering practices. All redundant systems and equipment capacities shall be approved by the appropriate FAA representative.

3.5.3.9.5 HVAC systems performance. Verification of optional HVAC systems performance shall be conducted in accordance with the SMACNA HVAC Systems Commissioning Manual. Commissioning committee and responsibilities shall be determined by the appropriate FAA representative.

3.5.4 Plumbing systems and equipment. Plumbing/sanitary systems and equipment shall be provided at all NAS facilities as specified by FAA Order 6960.1, applicable codes i.e., FAA-STD-033 and herein. All plumbing systems installed in new and renovated FAA facilities shall satisfy the requirements of the Americans with Disabilities Act (ADA), the Uniform Federal Accessibility Standard (UFAS) except where specifically exempted by engineering requirement, specification or task order; or directed by FAA.

3.5.4.1 Plumbing fixtures. All plumbing fixtures shall be in accordance with Uniform Plumbing Code, the National Standard Plumbing Code, the BOCA National Plumbing Code and any applicable local Code.

3.5.4.1.1 Floor drains/sinks. Floor drains and sinks shall be installed in Mechanical Equipment Rooms, Toilet Rooms, Janitors Closets and elsewhere as required by applicable Codes and where directed by the appropriate FAA representative. All floor drains shall be connected to the sanitary system. All floor drains shall have removable strainers and traps with minimum 2-inch water seal and with trap primers. Floor drains in engine generator rooms and similar areas which may receive spilled fuel or oil shall have their waste conducted through an oil separator from which separated oil is diverted to a waste oil storage tank.

3.5.4.2 Facility water systems. The facility domestic water system shall conduct water from the water supply service lines to the point of use in the facility. The domestic water system shall include water distribution piping, pumps and supply and/or pressure tanks as required.

3.5.4.2.1 Water pressure booster pump. Water pressure booster pumps shall be provided at locations where the main water service pressure is less than 30 psig and elsewhere when required. The water pressure booster system shall be a duplex arrangement with a primary and standby pump automatically alternated and operated by level and/or pressure controls and an alternator. A water pressure booster system shall be provided as required.

3.5.4.2.2 Heat tapes. Thermostatically controlled heat tapes shall be provided for all water and drain (sanitary and storm) pipes where exposed to freezing conditions. Visual indicator for "ON" condition shall be provided.

3.5.5 Sound and vibration control for mechanical systems and equipment. Sound and vibration control shall be provided for, but not limited to HVAC systems, machinery, rotating equipment, plumbing systems and electrical machinery and equipment. Sound and vibration control design methods shall be in accordance with ASHRAE Handbook, - HVAC Applications. Vibration control shall be designed to incorporate the requirements for seismic design.

3.5.5.1 Industrial sound levels. Sound levels in industrial spaces such as machine rooms, engine generator rooms and maintenance shops shall be in accordance with OSHA criteria.

3.5.5.2 Outdoor sound levels. Outdoor sound levels produced by FAA facility equipment shall not exceed indoor and outdoor levels allowable by local codes and regulations and shall also be in accordance with FAA Order 1050.1 and, where applicable, FAA Order 5050.4.

3.5.5.3 Seismic requirements for mechanical systems. Analysis of seismic loading shall be provided for all support systems, including pads for pad-mounted equipment. Seismic design shall be in accordance with ASCE 7. For National Standard Designs, Av shall be not less than 0.1 and the Seismic Hazard Exposure Group shall be III. Seismic bracing for ductwork and piping shall be in conformance with SMACNA Seismic Restraint Manual.

3.5.6 Fuel and oil storage tanks. Fuel (including propane) and oil, (including waste oil), storage tanks shall be installed in accorance with FAA order 1050.15, and shall be located for easy access for filling, pumping out and maintenance. Fuel storage tanks shall be sized for minimum of 72 hours continuous operation of engine generators. Where common fuel tanks serve engine generators and boilers, the tank capacity shall be such that engine generators can be operated for the same period while simultaneously supplying fuel to the boilers. Installation of new tanks and corrective action for existing tanks, including spill prevention, containment measures, testing and monitoring, and exhaust (for propane tanks) shall be in accordance with the provisions of NFPA or state and local environmental protection regulations, whichever is more stringent. Tanks shall be warranted for minimum 25 years service life.

3.6 Electrical engineering. This section provides basic engineering guidance and standards for design of all interior and exterior electrical systems. The intent is to provide electrical systems that are efficient, reliable and economical to operate and maintain. FAA national standard designs shall comply with the Uniform Building Code, Uniform Building Code Standards, Uniform Fire Code and the National Electrical Code. All electrical work shall be in accordance with FAA Orders 6030.20, and FAA Order 6950.2, FAA Standards FAA-STD-019, FAA-STD-020, IEEE STD-1100-1992 "Powering and Grounding Sensitive Electronic Equipment, specification FAA-C-1217 and shall comply with recognized national, or uniform codes and standards. Recognized codes and standards for site adapted designs include the following:

a. The BOCA National Building Code
b. National Electrical Code (NEC)
c. National Life Safety Code
d. National Fire Code (NFC)
e. Standard Building Code
f. Uniform Building Code
g. Uniform Fire Code

3.6.1 General electrical design considerations. All designs shall be of current proven technology. Systems and equipment shall be reliable, maintainable, readily available in the market place and of high quality. Except as modified herein, all electrical systems shall be designed in accordance with applicable publications of the following:

a. Illuminating Engineering Society (IES)
b. Institute of Electrical and Electronics Engineers (IEEE)
c. National Electrical Manufacturers Association (NEMA)
d. National Fire Protection Association (NFPA)
e. Underwriters Laboratory, Inc. (UL)

3.6.1.1 Polychlorinated biphenyls (PCB). All equipment and components of all electrical systems shall be free of PCBs. Disposal of all PCB items (transformers, ballast, capacitors) will be achieved per FAA order 1050.14.

3.6.1.2 Mechanical equipment coordination. The electrical design shall be closely coordinated with the mechanical design to ensure the required reliability and maintainability of both systems. This includes supplying the required power quality and maintaining the continuity of the control and monitoring systems. The design shall ensure compatible functioning and all critical electrical alarms, electrical KW and KWH energy data reporting and required RMMS (Remote Monitoring and Maintenance System), or DDC (Direct Digital Control) system. All relevant existing circuits must be included with the equipment coordination.

3.6.1.3 Selective overcurrent protection. A proper, fully selective, overcurrent protection system shall be designed for all new electrical work. A complete design analysis including FAA approved 20 year load study, breaker coordination and harmonic analysis shall be made and all design data and coordination curves shall comply with FAA Order 6950.27, Short Circuit Analysis be included in the Design Data Summary Handbook. All existing circuits shall be included in the Short Circuit Analysis and Protective Coordination Study. Power capacity and power requirements shall be addressed for each site. Power configurations and power quality criteria are stipulated in Order 6950.2, "Electrical Power Policy Implementation at National Airspace System Facilities". Modifications to existing facilities shall be evaluated to ensure compatibility with existing systems. A complete electrical coordination study should be performed prior to making changes to the Electrical Distribution System.

3.6.1.4 Available fault current. A Short Circuit Analysis and Protective Devise Coordination Study shall be completed in accordance with FAA order 6950.27. Existing circuits must be included in the Fault Current Analysis, where applicable. These calculations shall be included in the Design Data Summary Handbook. The equipment capacity and fault current shall be based on a 20 year load study of the equipment to be powered, as approved by the FAA.

3.6.1.5 Existing electrical circuits. Calculations for each site shall be made to ensure that any existing electrical circuits which must be altered are reconnected as needed to maintain operation of the existing facility systems. The design shall identify any temporary electrical connections that may be necessary to maintain operation of all systems during construction.

3.6.1.6 Metering. Metering shall be fully coordinated with the utility company.

3.6.1.7 Spare capacity. Spare capacity of at least 25 percent shall also be provided in all portions of electrical power distribution systems.

3.6.1.8 Facility specific requirements.

3.6.1.8.1 ATCT/TRACON/ARTS facilities. Electrical systems of ATCT/TRACON/ARTS facilities shall be in accordance with FAA Order 6480.7.

3.6.1.8.2 ARTCCs. Power distribution at ARTCCs shall be in accordance with FAA Orders 6950.15 and 6480.7.

3.6.2 Exterior electrical systems.

3.6.2.1 Overhead power distribution. Avoid the use of overhead power lines whenever feasible.

3.6.2.1.1 Conductors. Conductors shall have adequate strength for span lengths and loading conditions. In heavy storm areas, where high reliability is required, insulated conductor, pre-assembled, sheathed (metallic or non-metallic), messenger-supported aerial cable shall be used. Other measures may be required in areas with highly corrosive atmospheric condition such as near salt water or heavy industry.

3.6.2.1.2 Hardware components. Designs shall maximize the use of radio-freed insulators and hardware components that prevent loosening of connections even when wood members shrink.

3.6.2.1.3 Service drops. Service drop to buildings shall be underground from service pole into building. These conductors shall be enclosed in conduit in accordance with FAA-STD-019. Primary service drops shall be underground from service pole to pad mounted transformer and underground from transformer secondary compartment in to building.

3.6.2.1.4 Wooden poles. Wooden poles used in connection with antennae, obstruction lighting, flood lighting, utility lines and similar usages shall be in accordance with FAA-E-113.

3.6.2.2 Underground power distribution. Underground power distribution systems are preferred.

3.6.2.2.1 Underground cables. All service conductors shall be enclosed in Rigid Galvanized Steel (RGS) conduit in accordance with FAA-STD-019. Cable, wire and conductor insulation material shall depend on the system voltage and the thermal, mechanical and chemical effects involved in each particular application. All cables rated 2400 Volts or above and all cables exposed to the possible failure of other cables operating at these voltages shall be fireproofed in manholes, handboxes and other enclosures (as defined in 6.2.2). Except as provided herein, all multiconductor cables installed underground at FAA facilities shall be armored. Power cable shall be armored in accordance with FAA-E-2013, Type II. Control cable shall be armored in accordance with FAA-E-2042, Type 1B, 2B or 3B. Telephone cable shall be armored in accordance with FAA-E-2072, Type II. Coaxial cables RG-11A/U and RG-35B/U shall be armored in accordance with FAA-E-2171 and FAA-E-2619 respectively.

3.6.2.2.1.1 Cables not requiring armor. Armored cables are not required under any of the following conditions:

a. When the cable is to be installed in an area free of rodents or insects likely to cause cable damage and damage due to frequent construction activities is not likely; the cable has a jacket specifically suited for direct earth burial; and the cable is no smaller in size than 1 conductor 8 AWG or 6 pair 19 AWG;
b. When non-armored cable is indicated on approved standard drawings or specifications;
c. Where the cable is furnished, installed and maintained by local utility companies;
d. When the cable is to be installed in rigid steel conduit, rigid heavy wall plastic conduit or concrete-encased duct;
e. When the cable is to be embedded in sawed-cuts in runway pavement.

3.6.2.2.1.2 Protection. Protection in the form of rigid steel conduit, rigid heavy wall plastic conduit or concrete-encased duct for cables greater than that provided by armor shall be provided when the following conditions are present:

a. When the cables are to be installed under railroad tracks or paved surfaces such as roads, runways, aprons and taxiways;
b. When the cables are to be installed in areas where heavy vehicular traffic or frequent construction activities are likely to cause cable damage;
c. When space is available in an existing rigid steel conduit, rigid heavy wall plastic conduit or concrete-encased duct;
d. When critical operating requirements or severe site conditions require the additional protection of a duct or conduit system.

3.6.2.2.1.3 Direct earth burial. Direct earth burial cables and conductors may be used except when conditions are present as described in Paragraph 3.6.2.2.1.2. Power supply conductors shall be installed in concrete encased conduit to the maximum practical extent.

3.6.2.2.2 Direct Burial Systems.

a. Control and signal cables may be installed without separation.
b. Unless otherwise indicated, cables of the same or similar systems that are running in the same general direction shall be installed in the same trench.
c. Separation Between Direct Earth Burial Cables

1. Power cables of the same feeder circuit may be laid in the same trench without separation.
2. Power cables of different feeder circuits of less than 600 volts may be laid in the same trench with separation to protect each feeder from damage from other feeder.
3. Power cables rated 5000 volts shall be separated by a minimum of 6 inches with proper shielding from all other power cables rated 600 volts and below, and 6'-0" minimum from all control and signal cables.
4. Power cables of more than 5000 volts shall be separated a minimum of 12 inches from power cables rated 5000 volts and below, and from all control and signal cables.
5. Backfill separating cables shall be firmly tamped.
6. Where cables of different types (i.e., power and control or signal) of different voltages are jointly installed as indicated above, the individual cables or groups of cables shall be clearly and unambiguously identified by voltage and type.

3.6.2.2.3 Duct systems. Draw-in Duct systems. Draw-in systems, i.e. cable-in-duct, shall be provided where reliability is a major concern.

3.6.2.2.3.1 Duct lines. Duct lines shall be routed to avoid building and structure foundations for future (or existing) buildings and structures. Power and communication separations shall be in accordance with FAA-C-1391. Power and communications ducts shall be kept clear of all other underground utilities. Positive drainage shall be provided for all duct lines. Ducts shall drain toward

accessible low points. The power and communications underground duct lines must be routed in separate duct banks that are properly shielded and separated by at least six feet.

3.6.2.2.3.2 Manholes and handboxes. Manholes and handboxes shall be selected based on cable racking arrangement, method of drainage, adequacy of work space and integrity of waterproofing. Manholes and handboxes shall be spaced as necessary to prevent damage to cable insulation during installation. In no case shall spacing exceed 600 feet for straight duct runs or 300 feet where there is a bend in duct runs between manholes. Provide a ground rod for every manhole and handbox. All manholes and handboxes shall be connected to the ground rods. In addition, provide a #4/0 bare copper grounding conductor throughout the entire duct line with bonding at manhole/handbox system.

3.6.2.2.4 Cable loop systems. Cable loop systems at designated airports shall be in accordance with FAA Order 6950.23. Designs for underground power distribution shall consider the requirements imposed by existing or planned cable loop systems.

3.6.2.3 Transformers and distribution equipment.

3.6.2.3.1 Transformers. Transformers shall be selected based on ambient conditions, basic impulse insulation level, internal impedance power utilization requirements and life cycle cost analysis. The use of flammable transformer liquids should be avoided; however, if used, such transformers shall be located a minimum of 20 feet from egress paths and doors, windows, louvers or other openings in building exterior walls. All transformers should be energy efficient types, K rated, and 80° C rise. Primary transformers shall be physically separated to preclude the possibility of a single catastrophic event disabling both transformers.

3.6.2.3.2 Circuit interrupting devices. Circuit interrupting devices shall be rated in accordance with current carrying capacities and fault interrupting duties. All devices 225 amp/3 pole or larger shall be solid state type including a ground fault option. All 240 volt devices shall be 22kAIC or higher. All 480 volt devices shall be 25kAIC or higher.

3.6.2.4 Lighting systems. All exterior lighting systems shall be designed in accordance with the Illuminating Engineering Society (IES), Lighting Handbook and requirements of the American Association of State Highway and Transportation Officials (AASHTO). Site areas which shall be lit include, but shall not be limited to, entries, walkways between entry and designated parking areas, site entry gate, parking lot spaces, facility sign and other specific site locations commonly active during hours of darkness. Appropriate lighting controls that limit lighting to the period of activity shall be provided.

3.6.2.4.1 Street lighting. Illumination level shall be 0.6 to 2.0 footcandles average maintained with 3:1 uniformity ratio. Illumination level on roadways shall match level on adjacent roadways subject to above restriction.

3.6.2.4.2 Area lighting. Illumination level for parking areas shall be 0.6 to 1.0 footcandle average maintained with 4:1 uniformity ratio, and for walkways shall be 0.1 to 0.6 footcandles with 6:1 uniformity.

3.6.2.4.3 Security/protective lighting. All security/protective lighting system shall be designed in accordance with FAA Order 1600.6B. Emergency power sources are required for this type system.

3.6.2.4.4 Special considerations. Exterior lighting units in the vicinity of airfields shall be aimed or shielded so that no direct or stray light is emitted above the horizontal to interfere with the nighttime visibility of control tower operators or to be confused with runway navigational lights by air traffic. Light sources should be compatible with adjacent areas.

3.6.2.4.5 Obstruction lights. Obstruction lights shall be provided as required in FAA AC 70/7460-1.

3.6.2.4.6 Circuit design. All new systems shall utilize underground distribution, except short extensions to existing systems shall match existing distribution type.

3.6.2.4.6.1 Multiple systems. Multiple systems shall be used for all new work, for extensions to existing multiple systems and for extensive additions to existing series systems.

3.6.2.4.6.2 Series systems. Series systems shall be used only for short extensions to existing series systems where its use is more economical than multiple systems.

3.6.2.4.7 Lighting intensities. Lighting intensities shall be based on initial lamp/fixture output and lamp lumen depreciation. Luminaire dirt depreciation shall be assumed to be negligible.

3.6.3 Interior electrical systems. All interior electrical systems shall be in accordance with FAA-C-1217.

3.6.3.1 Power distribution.

3.6.3.1.1 WIRING. Unless otherwise specified, all power conductors from the utility feeder down through the power panels shall be installed in conduit. This does not necessarily apply to power conductors between power panels and individual pieces of equipment. shall be installed in conduit. The conduit shall be concealed in walls, ceilings or floor in finished area.

3.6.3.1.2 Conductors. Thermal withstand capabilities of conductors and conductor bracing shall be based on available fault level and duration.

3.6.3.1.3 Panelboards. All panelboards shall be sized to include at least twenty-five (25) percent spare capacity. All busing shall be braced for available fault current.

3.6.3.1.4 NOT USED.

3.6.3.1.5 Transformers.

3.6.3.1.5.1 Selection. Indoor transformers shall be energy efficient dry types-rated at 40° C with an 80°C winding temperature rise with 150° C insulation.

3.6.3.1.5.2 Transformer sizing. All transformers shall be sized to include at least twenty-five (25) percent spare capacity over and above the calculated connected load.

3.6.3.1.5.3 Transformer insulation system. All transformers shall be capable of continuously carrying a load equivalent to 115 percent of the rated nameplate volt-amperes without exceeding the rating of the insulation.

3.6.3.1.6 Distribution equipment.

3.6.3.1.6.1 Secondary service feeder disconnect switches. FAA standard distribution systems configuration shall be 480 volt, 3 phase, 3 wire wye with delta HV primary. A service disconnect switch shall be provided on the outside of the building or facility on the secondary side of the main transformer. The disconnect switch shall be sized to address the load of the facility and be contained in a weatherproof enclosure with utility metering. Additionally, disconnect the switch shall be grounded to the counterpoise grounding system.

3.6.3.1.6.2 Substations. Substations with a primary voltage of 15 kV or less may be installed indoors. Location and quantity of substations shall be based on the most economical balance between the cost of a secondary distribution system and the cost of transformers, switchgear and primary distribution. The standard FAA distribution system is a 480 volt, 3 phase, 3 wire grounded wye secondary with delta primary with the service disconnect grounded to the counterpoise external to the building.

3.6.3.1.6.3 Switchboards. Deadfront distribution switchboards shall be the individually mounted and individually compartmented type. When used as service equipment, switchboards shall be labeled as service entrance equipment. The switchboard shall have a 480 volt, 3 phase, 3 wire wye secondary with delta primary configuration. All 480/277 volt and 120/208 volt systems shall be separately derived with transformers located near load panels to minimize harmonic noise circulating in building steel.

3.6.3.1.6.4 Power switchgear assemblies. When used as service equipment, power switchgear assemblies shall be labeled as service entrance equipment. The power switchgear assembly shall be configured as 480 volt, 3 phase, 3 wire wye when applied as service entrance equipment. All 480/277 volt and 120/208 volt systems shall be separately derived.

3.6.3.2 Wire communications and signal systems. EIA/TIA standards 568, 569, and 606 shall be used for design of all communication cabling specifications.

3.6.3.2.1 Telephone system. An empty conduit system shall be provided for the telephone system in administrative and office areas. Unless otherwise required, a cable tray system shall be provided for the telephone system in other areas. Requirements for the conduit or tray system shall be coordinated with the local telephone company and the designated approval authority for the facility.

3.6.3.2.2 Empty conduit. System design shall be coordinated with the designated approval authority for the equipment layout. Empty conduit systems shall be provided for the following:

a. Intercom systems;
b. Public address or paging systems;
c. Intrusion alarm systems.

3.6.3.2.3 Cable tray systems. Cable tray systems shall be provided as required to provide a properly shielded routing method for data and signal cables. A separate cable tray system can be used for power conductors and shall the separation requirements indicated above including proper shielding. Cable tray raceway system shall be a minimum of 4 inches deep. In order to insure proper shielding the tray must have a solid bottom. System installation must be coordinated with specific equipment layout applications. Signal cable trays should cross cable trays by right angles. Avoid locating any cable tray in fire rated corridors or means of egress. The cabling should be easily accessible for maintenance purposes.

3.6.3.3 Lighting systems. The interior lighting system shall use energy efficitent lighting fixtures designed to provide a comfortable and acceptable lighting level in task areas, and a sufficient ambient lighting level to permit ease of circulation throughout the space for personnel. The color rendering of the lighting system shall neither degrade the function of the space nor impact upon any aspect of safety.

3.6.3.3.1 Illumination levels. The IES Lighting Handbook shall be utilized to provide adequate lighting levels for a given space. The values indicated in the Handbook should not be exceeded. When circumstances permit, lower lighting levels should be given consideration, provided that the lighting level application is consistent with the nature and type of occupancy and activity. Energy consumption goal shall also remain in the forefront of any lighting design that is being considered. All lighting calculations shall be based upon the methodology furnished in the IES handbook. The use of computer assisted lighting applications programs are encouraged in order to help determine the most cost effective lighting technique. Low brightness, non-glaring luminaries shall be applied to all CRT areas, indicating panel locations, and in all computer room applications. Low energy consumption lighting fixtures shall be used whenever possible.

3.6.3.3.2 Incandescent lighting fixtures. Incandescent lighting fixtures may be utilized only in areas where intermittent use is anticipated, such as closets or and small toilets, or special applications.

3.6.3.3.3 Emergency lighting equipment.

3.6.3.3.3.1 Facilities without engine generator sets. Emergency lighting shall be provided by battery powered lighting as follows:

a. Illumination of exits, corridors and stairs;
b. Interior spaces housing critical electrical and mechanical equipment;
c. Critical (including Operations) areas having electronic equipment.
d. Toilet areas.

Unless otherwise specified, batteries shall be sized for 1-1/2 hours of operation after failure of normal power.

3.6.3.3.3.2 Facilities with engine generator sets. The emergency lighting shall be as follows:

a. Battery lights in equipment rooms, egress routes, engine/generator rooms, electrical rooms, computer rooms and control rooms, as applicable.
b. Lighting connected to the emergency power circuits in all occupied spaces, electrical/mechanical room, break room and lavatory;
c. Exit corridors and vestibules shall have sufficient lighting connected to the emergency system to provide emergency egress illumination.

3.6.3.3.3.3 Remote unmanned facilities. Emergency lighting shall not be provided at these facilities.

3.6.3.3.4 Cleaning lights. Cleaning lights shall be provided in areas where low ambient lighting is required and shall be controlled by a key operated switch.

3.6.3.4 Motors and motor controllers.

3.6.3.4.1 Motors. Motor selection, i.e., single phase versus three phase, shall be based on the loading impact to the distribution system. All motors one-half horsepower and larger shall be three-phase. Motors less than one-half horsepower shall be single-phase. All motors shall be the energy efficient type.

3.6.3.4.2 Motor controllers. All motor controllers whether or not contained in a motor control center, shall be the product of the same manufacturer. When motor controllers are an integral part of an assembly, the manufacturer requirement will not apply. Reduced voltage controllers shall be required for 40 horsepower or larger motors and smaller motors when requested by the utility company or where otherwise indicated.

3.6.3.4.3 Motor control centers. Motor control centers shall be used whenever four or more motor controllers would otherwise be grouped in close proximity. Busing shall be designed in such a way that the motor control center can be expended from both ends. Adequate space shall be provided around equipment to allow for expansion without impinging on NEC minimum required working space. Terminal blocks shall be the plug-in type so that controllers can be removed without the need to disconnect individual wiring. Controllers should be individually mounted and compartmented. Motor control centers shall be 480 volt, 3 phase, 3 wire wye braced for 65 kAIC with main lugs only (MLO). All bussing within the motor control center shall be copper.

3.6.4 Standby power systems. Standby power systems shall be in accordance with FAA Order 6030.20. It must be installed per FAA-C-1244. The generator shall be pre-packaged spark ignited sets designed for the indicated voltage. Sets larger than 200 KW that are used for emergency backup should be so configured as to be able to synchronize with the local utility for closed transition transfer (and peak shaving on The utility grid). A provision should also be included for waste heat recovery from the generator exhaust and water jacket system where cost effective. Units for outdoor

installation shall be provided with a weather resistant housing. All units shall be delivered from the manufacturer pre-tested and ready for pad mounting.

3.6.4.1 DC power system. All dc power systems shall be in accordance with FAA Orders 6980.24 and 6980.26. DC systems shall provide power at 12, 24, 36 or 48 volts. The dc power system shall consist of the following:

a. Panel, sized as required;
b. A battery system capable of sustained operation of the equipment for a period specified in FAA Order 6950.2 or the equipment specifications.
c. Equipment that is capable of providing voltages within the nominal voltage ranges defined in FAA-G-2100, whether being energized by normal power, from battery alone or during transition or charging periods.
d. Rectifier with sufficient capacity to supply dc power to the equipment and recharge the battery within 12 hours following a four-hour operation of the battery. Maximum dc output ripple to equipment shall not exceed 100 millivolts peak when energized by normal power and without battery connected.

3.6.5 Grounding, bonding and shielding systems. Grounding, bonding, and shielding systems shall be provided in accordance with FAA-STD-019 and IEEE STD 142-1991. Critical loads that shall be served by 30-75 KVA wye/delta transformers, which may include filters or harmonics canceling windings, should be located no more than 6 feet from the electronic equipment ground. Electronic loads served on a raised computer floor should include a signal reference grid (SRG) under the raised floor system bonded to every 3 feet flooring system. All work done under this section shall be oriented to produce an electrically quiet environment consistent with the use or reduced voltage logic level equipment.

3.6.6 Lightning and transient protection systems. Lightning and transient protection systems shall be in accordance with FAA-STD-020 and FAA-G-2100.

3.6.7 Electromagnetic interference (EMI). EMI is a major concern for NAS facilities. EMI shall be minimized and all designs shall be in accordance with FAA-STD-020 and FAA-G-2100.

3.6.8 Seismic requirements for support systems. Analysis of seismic loading shall be provided for all support systems including, but not limited to, lighting fixtures supports and pads for pad-mounted equipment.Seismic design for national standard designs shall be in accordance to ASCE 7, whereas Av shall not be less than 0.1 and Seismic Hazard Exposure Group III. Bus duct should be installed so that the connections to the switchgear will not be damaged in event of a seismic incident to protect the bus duct joints.

3.6.9 Cathodic protection. Cathodic protection shall be evaluated for the following:

a. Underground metallic pipes, structures and foundations;
b. Interior of elevated steel tanks;

c. Exterior and interior surfaces of buried, or partially buried, steel tanks and large metallic pipes;
d. Lead-covered cables;
e. Submersible-type equipment in manholes and underground vaults subject to frequent immersion;
f. Metallic structures submerged in water.

Cathodic protection shall be of the galvanic or applied potential type. Life-cycle cost analysis shall be used to determine the economic feasibility of cathodic protection.

3.6.10 Battery system. Battery systems shall be in accordance with FAA Orders 6980.24 and 6980.26.

3.6.11 Alternative or renewable power sources. Alternate and renewable power sources shall be in accordance with FAA Order 6980.26. Alternative or renewable power sources shall be considered for remote facilities, and other facilities where shown to be economically feasible. Any non-utility type source must be shown to be equal in reliability to a utility provided power source, and require a minimum of maintenance and monitoring. Alternative and renewable power sources shall be in accordance with FAA Order 6980.26. Designs and products specified shall be in conformance with Executive Order 12902, Energy Efficiency and Water Conservation at Federal Facilities, and the 1992 Federal Energy Policy Act. Designers are to be aware of section 152(h)(2) of EPACT 1992 requiring Federal Facilities to participate with government purchasing power in promoting the development and commercialization of energy efficient products including photovoltaic, wind energy and fuel cells.

3.7 Life safety and fire protection. Buildings and structures shall be designed to avoid undue danger to the lives and safety of the occupants and to the equipment and facilities.

3.7.1 Standards. Except as provided herein, life safety and fire protection requirements shall be in accordance with FAA Order 3900.19 and shall comply with recognized national, standard, or to uniform codes and standards applicable to the specific facility location. Fire Protection of computer facilities shall be in conformance with FAA Order 1600.54. FAA national standard designs shall comply with the Uniform Building Code, and Uniform Fire Code. Recognized codes and standards for site adapted designs include the following:

a. The BOCA Basic/National Building Code
b. The BOCA National Fire Prevention Code
c. The BOCA National Plumbing Code
d. Fire Protection Handbook
e. National Fire Protection Association (NFPA) Fire Codes
f. National Fire Protection Association (NFPA) Life Safety Code
g. National Fire Protection Association (NFPA) Handbook
h. National Electrical Code (NEC)
i. The Southern Standard Building Code
j. The Southern Standard Plumbing Code
k. The Southern Standard Fire Prevention Code

l. The National Standard Plumbing Code

3.7.1.1 Relevant factors. Factors relevant to life safety and fire protection systems shall include, but not be limited to, the following:

a. Aisles and walkways;
b. Floors;
c. Stairs;
d. Doors;
e. Means of egress;
f. Warning signs and barricades;
g. Hazardous contents;
h. Ramps;
i. Hazardous areas;
j. Fire walls, partitions and steps;
k. Emergency lighting;
l. Fire and smoke detection and alarm;
m. Fire extinguishing systems including sprinklers, hose and standpipe, fire hydrants, halon and carbon dioxide systems and other gaseous agents;
n. Location and number of portable fire extinguishers;
o. Mechanical smoke evacuation means.

3.7.2 Local code considerations. Consideration shall be given to fire regulations promulgated by local authorities. Where designs or construction details conflict with the requirements of local fire authorities and the problems cannot be resolved without detriment to the FAA, such disagreement shall be immediately reported to the appropriate FAA representative for resolution.

3.7.3 Life safety and fire protection specific requirements for ATCTs, ARTCCs, and similar facilities. Life safety and fire protection specific requirements for ATCTs, ARTCCs and similar facilities shall be in accordance with NFPA Fire and Life Safety Codes. Additional requirements for ATCTs are provided in FAA Order 6480.7.

3.7.3.1 Computer rooms and electronic equipment areas. Computer rooms and electronic equipment areas shall be constructed of fire resistant material to preclude the need for automatic sprinklers. Fire extinguishing systems shall be provided in accordance with FAA Order 1600.54.

3.7.3.2 Additional fire detection and alarm system requirements. Unless otherwise specified, in addition to fire detection and alarm system requirements cited in FAA Order 1600.54, the detection and alarm system for areas in which gaseous fire extinguishing equipment is installed shall also comply with the following requirements.

a. The system shall allow for safe, efficient and complete evacuation of all personnel from the affected area prior to automatic discharge of the gaseous extinguishing agent. The maximum delay between alarm and discharge shall be 1 minute, except as provided below.

b. Manually activated discharge of the agent shall be immediate and uninterruptible. The agent discharge manual pull stations shall be equipped with covers or other devices which prevent accidental discharge of the agent. Visible indication of an activated pull station shall be provided and shall remain noticeable until deliberately reset by authorized personnel. A key switch station shall allow for manual override of the automatic discharge timing sequence activated by cross-zoned detector circuits. The key switch stations shall be a maintained-type consisting of clearly marked abort, automatic and agent discharge functions. The abort function shall suspend the automatic sequence and prevent automatic agent discharge until the key switch station is returned to the automatic or discharge position.
c. Recirculating air handling units (AHUs) within the gaseous agent protected area shall continue to operate during agent discharge to facilitate the distribution of the agent.
d. Discharge of the gaseous agent shall be remotely signaled to the systems monitoring and maintenance console (SMMC), facility fire alarm panel, and shall illuminate an indicator light on the fire suppression control panel.

3.7.4 Portable fire extinguishers. Portable fire extinguishers shall be conspicuously located where they will be readily accessible and immediately available in the event of fire. The minimum quantity, size and types of fire extinguishers required shall be in accordance with FAA-STD-004.

3.7.5 Additional design criteria. Additional life safety and fire protection design criteria and not covered above shall be in accordance with the Fire Protection Handbook.

3.8 Quality assurance requirements. All design of new facilities and modifications to existing facilities shall be subject to the scrutiny of the Joint Acceptance Inspection.

3.8.1 Internal design review. The A/E shall continually monitor and fully coordinate all designs, site inspections, site investigations, reviews and document preparation efforts. Preparation of specialized portions of designs shall be accomplished, or supervised by, and certified by experienced persons having state registration in the applicable field. Original tracings of all drawings, the first page of all specifications, estimates and similar deliverables shall be certified and signed by the A/E. The signature shall appear under the A/E's printed name and over the affixed replica of the professional seal or registration certificate number. Unless otherwise waived by FAA, each deliverable item requiring signature shall bear the signature of the registered professional person of the respective disciplines: civil, structural, architectural, mechanical, electrical, fire protection etc. In addition all structural calculation sheets, divisions and other structural documents shall have the signature and zeal of a professional structural engineer. The requirement for signatures by registered professional structural engineers will not be waived.

3.8.1.1 Seismic zone IV. All structural documents prepared for Seismic Zone IV shall be sealed by a registered structural engineer from a state in which this facility will be located.

3.8.1.2 Unique design techniques. The A/E shall conduct such tests as are necessary to ensure validity of design techniques which have not been proven by previous application. The A/E shall prepare and submit reports on findings.

4. QUALITY ASSURANCE PROVISIONS

This section is not applicable to this standard.

5. PREPARATION FOR DELIVERY

This section is not applicable to this standard.

6. NOTES

6.1 Additional data required. Attention of procurement request initiators is invited to the items listed below which should be covered in the system/subsystem or engineering services specification or contract schedule.

6.1.1 General requirements. Specifications should not categorically impose all requirements of this standard. Impose only those requirements which are applicable to the specific project. Identify FAA system/subsystem or equipment to be served by the physical facility, the number and type of operating positions, training, administrative, related maintenance and storage activities, protection and security requirements. Note exceptional cases and provide written authorization where compliance to local codes precedes compliance to nationally recognized codes (3.1).

6.1.2 Environmental impact. Identify those facilities for which previous environmental impact statements (EISs), environmental assessments or categorical exclusions exempt the new facility from further assessment and reporting (3.1.2.1).

6.1.3 Construction scheduling. Identify those facilities for which critical path method (CPM) network schedule analysis is required to be prepared during design phase. Specify performance period and minimum number of activities to be considered and shown. Specify additional safety requirements to be imposed for design and construction of facilities or airports (3.1.4).

6.1.4 Construction safety at airports. Identify the airport operator or user who is to review and approve the safety plan. Specify necessary deviations from safety provisions identified in the Advisory Circular (3.1.4.4).

6.1.5 Engineering cost estimate. Provide approved cost estimating forms or approve cost estimating forms provided by the cost estimator (3.1.7.1).

6.1.6 Design implementation cost control. Identify project requiring cost control reporting (3.1.7.2).

6.1.7 Economic analysis. Identify major physical facility systems and items of equipment for which economic analysis is required. Identify economic life for the facility if different or not provided by this standard (3.1.9).

6.1.8 Provisions for the physically handicapped. Note any exceptions or exemptions to the requirements for provisions for the physically handicapped. Identify specific work areas and job

tasks anticipated or known for the handicapped at the facility (3.1.10). All areas shall be handicapped accessible unless specified exempted.

6.1.9 Design data summary handbook. Specify when the handbook is not required (3.1.13).

6.1.10 Mechanical and electrical system handbook. Specify when the handbook is not required (3.1.14).

6.1.11 Mechanical/electrical systems instruction book. Identify those facilities for which mechanical/electrical systems instruction book is required. This document provides comprehensive physical and functional system descriptions, design intent, operation and maintenance data and should only be required for those major or complex facilities for which the degree of detail implicit with this requirement can be justified (3.1.15).

6.1.12 Provisions for remote maintenance and monitoring system. Indicate RMMS requirements in terms of systems and equipment to be monitored or controlled. Indicate detector types, interface points and other pertinent data (3.1.16).

6.1.13 Soils report. Specify deviations from standard including whether or not report is required (3.2.2.3).

6.1.14 Vehicle parking. Identify the number and type (employee, visitor, handicap, etc.) of parking spaces required for a specific facility. Designate areas requiring vehicle heater receptacles (3.2.5.4).

6.1.15 Fencing. Identify those sites for which fencing is a requirement, identify electromagnetic interference (EMI) considerations; type of gates; locks and other site peculiar requirements (3.2.6).

6.1.16 Site planning. Specify site planning requirements including planned location of facilities (3.3.1.1).

6.1.17 Future expansion. Identify future planning requirements (3.3.1.3).

6.1.18 Organization of interior spaces. Identify facility population, administrative and extraordinary technical requirements.(3.3.2)

6.1.19 Construction systems. Identify applicable standard drawings and specifications for specific facility types (3.3.4).

6.1.20 Mobile facilities and systems. Specify additional requirements, including siting requirements, for mobile facilities and systems (3.3.4.6).

6.1.21 Toilet Facilities. Provide review and approval of designs of exterior toilet systems on a site-by-site basis (3.3.4.7).

6.1.2.2 Electrostatic discharge control. Identify areas within facility where electrostatic discharge control is required (3.3.5).

6.1.23 Building security systems. Identify sensitive national security data, communications and information areas within the physical facility. Provide requirements for system surveillance by the RMMS (3.3.8).

6.1.24 Qualifying criteria for providing temperature and humidity control equipment and systems. Submit updated list to A/E with revised categorization of facilities (3.5.2.1.1).

6.1.25 Interior environment. Identify extraordinary interior environmental conditions. Specify minimum and maximum temperature and humidity alarm set points where applicable. Identify electronic equipment heat contribution to room in which it is located (3.5.2.2.1).

6.1.26 Human occupancy factors. Specify human occupancy factors such as number of people, frequency and duration of occupancy, type of tasks indicating energy expenditure and other pertinent data (3.5.2.2.1.2).

6.1.27 System and Equipment Rundancy and Capacity Growth. Identify redundance requirements to support facility reliability, availability and maintainability requirements(3.5.3.9.4).

6.1.28 Cable loop system and capability. Identify planned or existing facilities with cable loop system. Specify requirements to be imposed for design and construction compatibility to the cable loop system (3.6.2.2.4).

6.1.29 Lighting systems. Identify areas of varying activity and periods of activity which would affect lighting controls (3.6.2.2).

6.1.30 Wire communication and signal systems. Identify empty raceway requirements for wire communication and signal systems to be provided by others (3.6.3.2).

6.1.31 Government furnished equipment. Identify equipment to be furnished by the government and installed under-facility construction contract.

6.1.33 Provisions for equipment furnished and installed under other contracts. Identify voltage, power and space requirements for electronic and data processing systems when furnished under other contracts.

6.1.34 Construction support activities. Indicate requirements for construction support activities including, but not limited to, construction inspections and supervision, shop drawing review and as-built preparation.

6.1.35 Internal design review. Indicate waived requirements and specify additional requirements for internal design review of documents and document preparation.

6.2 Acronyms, abbreviations and definitions.

6.2.1 Acronyms and abbreviations. The following are definitions of acronyms and abbreviations used in this standard.

A/E	Architect/Engineer
AAMA	Architectural Aluminum Manufacturer's Association
AASHTO	American Association of State Highway and Transportation Officials
ac	Alternating Current
ACGIH	American Conference of Government Industrial Hygienists
ACI	American Concrete Institute
ADA	Americans with Disabilities Act
AFM	Air Force Manual
AFSS	Automated Flight Service Station
AHU	Air Handling Unit
AISC	American Institute of Steel Construction
ANSI	American National Standards Institute
ARSR	Air Route Surveillance Radar
ARTCC	Air Route Traffic Control Center
ARTS	Automated Radar Terminal System
ASDE	Airport Surface Detection Equipment
ASHRAE	American Society of Heating, Refrigerating and Air Conditioning Engineers
ASR	Airport Surveillance Radar
ASTM	American Society for Testing and Materials
ATC	Air Traffic Control
ATCT	Airport Traffic Control Tower
AWG	American Wire Gauge
AWS	American Welding Society
Av	Affective Peak Velocity - Related Acceleration
BOCA	Building Officials and Code Administrators
CCMS	Central Control Monitoring System
CO	Carbon Dioxide
CPM	Critical Path Method
CRT	Cathode Ray Tube
DB	Dry Bulb
dc	Direct Current
DME	Distance Measuring Equipment
EIS	Environmental Impact Statement
EMI	Electromagnetic Interference
EPA	Environmental Protection Agency
ESD	Electrostatic Discharge
F	Fahrenheit
FAA	Federal Aviation Administration
FSS	Flight Service Stations
gal	Gallon

GFI	Ground Fault Interruption
HVAC	Heating, Ventilating and Air Conditioning
IAPMO	International Association of Plumbing and Mechanical Officials
IEEE	Institute of Electrical and Electronics Engineers
IES	Illuminating Engineering Society
kV	Kilovolt
lb	Pound
LEL	Lower Explosive Limit
LCC	Life Cycle Cost
max	Maximum
MCF	Metroplex Control Facility
min	Minimum
NAS	National Airspace System
NEC	National Electrical Code
NEMA	National Electrical Manufacturers Association
NFC	National Fire Code
NFPA	National Fire Protection Association
NEXRAD	Next Generation Weather Radar System
OSHA	Occupational Safety and Health Administration
PCB	Polychlorinated Biphenyls
PCS	Power Consitioning System
psig	Pounds per Square Inch, Gauge
RCAG	Remote Communication Air/Ground
RGS	Rigid Galvanized Steel
RH	Relative Humidity
RMMS	Remote Maintenance Monitoring System
RTR	Remote Transmitter/Receiver
SBCCI	Southern Building Code Congress International
SMACNA	Sheet Metal and Air Conditioning Contractors' National Association
SMMC	System Monitoring and Maintenance Console
sq ft	Square Feet
TACAN	Tactical Air Navigation Facility
TDWR	Terminal Doppler Weather Radar
TRACON	Terminal Radar Approach Control Facility
Temp	Temperature
UBC	Uniform Building Code
UBCS	Uniform Building Code Standards
UL	Underwriters Laboratories
UMC	Uniform Mechanical Code
UPC	Uniform Plumbing Code
UPS	Uninterruptible Power Source
UFAS	Uniform Federal Accessibility Standards
VOR	VHF Omnidirectional Range
VORTAC	VOR Collocated with TACAN
WB	Wet Bulb

6.2.2 Definitions.

6.2.2.1 Climatic zone. A geographic area with a defined range of summer and winter conditions.

6.2.2.2 Component. An element or subelement of a system or equipment which can be replaced and the failure of which would cause the failure of the system or equipment. Example: fan belt of a belt-driven fan.

6.2.2.3 Critical spaces. Spaces that provide the physical environment for equipment whose function or service, if lost, would prevent the NAS from exercising safe separation and control of aircraft.

6.2.2.4 Economic life. That life of a facility at the end of which the facility has no redeeming value and can no longer be used.

6.2.2.5 Essential/Critical. Functions or services that, if lost, would reduce the capability of the NAS to exercise safe separation and control of aircraft. Essential areas are backed up by generators and cirtical areas are backed up by an UPS.

6.2.2.6 Mission equipment. Equipment that is essential or critical to the utility of the NAS to exercise safe separation and control over aircraft.

6.2.2.7 Facility. The total plant required for a subelement or subsystem to function. The facility will house, support or protect the subelement or subsystem at a particular geographic location. The facility will have various physical characteristics in accordance with the function of the subelement or subsystem. The facility can be of the following types depending on the required function:

a. Building - Consists of walls, floor(s) and a roof either single story or multi-story constructed of various material; usually fixed in location and housing personnel and equipment. The building may include air conditioning, power etc., if required for the particular application.
b. Structure - Composed of interrelated parts which together form a structural entity, usually fixed in location containing equipment and which may be manned or unmanned. The structure may include air conditioning, power etc., if required for the particular application.
c. Enclosure - Interrelated parts which surround or shut in equipment, fixed or movable, usually unmanned. The enclosure may include air conditioning, power etc., if required for the particular application.
d. Assembly - Composed of interrelated parts which together form a functional entity, fixed or mobile, containing equipment.

6.2.2.8 Requirement. A specified capability which must be provided by the system, subsystem, end item, contractor, etc. Type of requirements include operational, functional, performance, interface, facility and verification requirements.

6.2.2.9 Support equipment. Equipment that provides electrical or environmental conditioning for mission equipment. HVAC and UPS/PCS are examples of support equipment.

6.2.2.10 Verification matrix. A formalized confirmation checklist of major design items, considerations and criteria etc. displayed in a rectangular array.

APPENDIX I

10. PHYSICAL FACILITY ECONOMIC LIFE

Facility Acronym	Facility Name	Economic Life (Years)
ACF	Area Control Facility	25
AFSS	Automated Flight Service Station	15
ARSR	Air Route Surveillance, Radar Transmitter/Receiver Building	15
ARTCC	Air Route Traffic Control Center	25
ARTS	Automated Radar Terminal System Building	15
ASDE	Airport Surface Detection Equipment Transmitter/Receiver Building	15
ASR	Airport Surveillance Radar Transmitter/Receiver Building	15
ATCCC	Air Traffic Control Command Center	20
ATCT	Airport Traffic Control Tower	20
FSS	Flight Service Station	20
IFSS	International Flight Service Station	20
MCF	Metroplex Control Facility	30
RCA	Remote Communications Air/Ground Facility	20
RTR-ATCT	Remote Transmitter/Receiver Building at an ATCT	20
RTR-FSS	Remote Transmitter/Receiver Building at an FSS	15
TRACON	Teminal Radar Approach Control Facility	15
VOR/VORTAC	VOR or VOR Collocated with TACAN	20

APPENDIX II

20. FIRE EXTINGUISHER DISTRIBUTION

20.1 Minimum Quantity and Type of Extinguisher NOTE 1

Room Type	Water Antifreeze and Loaded Stream	Carbon Dioxide CO	Dry Chemical	Halon 1301 Gaseous agent
AIR ROUTE TRAFFIC CONTROL CENTER	2-1/2 gal/3000 sq 1-ft or portion		NOTE 1	
Control Room		1-15 lb/1600 sq ft portion		NOTE 5
Electronic Equipment Wing		NOTE 2		
Computer Room		NOTE 2		
Electric Service Room		1 - 15 lb/1600 sq ft or portion		NOTE 5
Air Conditioning Equipment Room		2 - 15 lb		NOTE 5
Attic Space		1 - 15 lb/1600 sq ft or portion		NOTE 5
Boiler Room		2 - 15 lb		
Garage		1 - 15 lb	2 - 10 lb NOTE 3	NOTE 5
General Storage		1 - 15 lb		NOTE 5
Engine Generator Room		2 - 15 lb		NOTE 5
Kitchen		1 - 15 lb	2 - 5 lb multipurpose NOTE 4	NOTE 5
Office Space	1 - 2-1/2 gal/3000 sq ft or portion			
Security Building		1 - 15 lb		NOTE 5
Telco Room		2 - 15 lb		NOTE 5

PCS UPS Equipment Room	3 - 15 lb		NOTE 5
PCS UPS Battery Room	2 - 15 lb		NOTE 5
OTHER FAA FACILITIES			
Boiler Room	1 - 15 lb		NOTE 5
Computer RoomNOTE 2			
Electric Service Room	1 - 15 lb/6000 sq ft or portion		NOTE 5
Electric, Electronic Storage	1 - 15 lb/6000 sq ft or portion		NOTE 5
Electronic Equipment Room	1 - 15 lb/6000 sq ft or portion		NOTE 5
Engine-Generator Room	1 - 15 lb		
Furnace Room	1 - 15 lb		
Garage and Gasoline Station	1 - 15 lb	2 - 10 lb	NOTE 3
General Storage	1 - 15 lb		
Kitchen	1 - 15 lb	2 - 15 lb multipurpose	NOTE 4
Mechanical Equipment Room	1 - 15 lb/1600 sq ft or portion		NOTE 5
Living Quarter Kitchen		1 - 2-1/2 lb multipurpose	
Telco Equipment Room	2 - 15 lb		
Tower Cab	1 - 15 lb/1600 sq ft or portion		
TRACON Room	1 - 15 lb/1600 sq ft or portion		
Shop (maint.)	1 - 15 lb		
Shop, Flammable Metal	1 - 15 lb	Class D 5 lbs/lb flammable metal	
PCS UPS Equipment Room	3-15 lb		NOTE 5
PCS UPS Battery Room	2 - 15 lb		

20.1.1 NOTES.

1. A 10 pound multipurpose dry chemical extinguisher may be used in lieu of a water extinguisher except in electrical/electronic equipment areas. Neither dry chemical extinguishers nor water extinguishers shall be used on electrical/electronic equipment. Antifreeze extinguishers shall be used in areas subject to freezing temperatures to -40 degrees Fahrenheit. Below -40 degrees Fahrenheit, extinguishers shall be placed in enclosures to maintain the temperature with specified limits.

2. Stationary extinguisher units consisting of two carbon dioxide cylinders having a minimum capacity of 50 lbs. each shall be installed. Each stationary unit shall be manifolded to a hose reel, holding 100 feet of 1/2" carbon dioxide hose and a horn shaped nozzle, and located so that at least two fire hoses can reach any point in the electronic equipment room. Additional fifteen lbs. extinguishers will be added to be accessible within not more than 50 feet from any point within the room.

3. Extinguishers shall be installed in suitable enclosures outside of each garage and gasoline dispensing station.

4. One five lbs. multipurpose dry chemical extinguisher shall be installed adjacent to the kitchen.

5. Halon 1301 Non-ozone depleting gaseous extinguishers may be used instead of carbon dioxide extinguishers. One four lbs. Halon extinguisher is equivalent to a fifteen lbs. carbon dioxide extinguisher. In electric, electronic equipment and telco rooms, Halon 1301 non-ozone depleting gaseous extinguishers shall be preferred over carbon dioxide extinguishers.

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